CANADA CENTRE FOR INLAND WATERS

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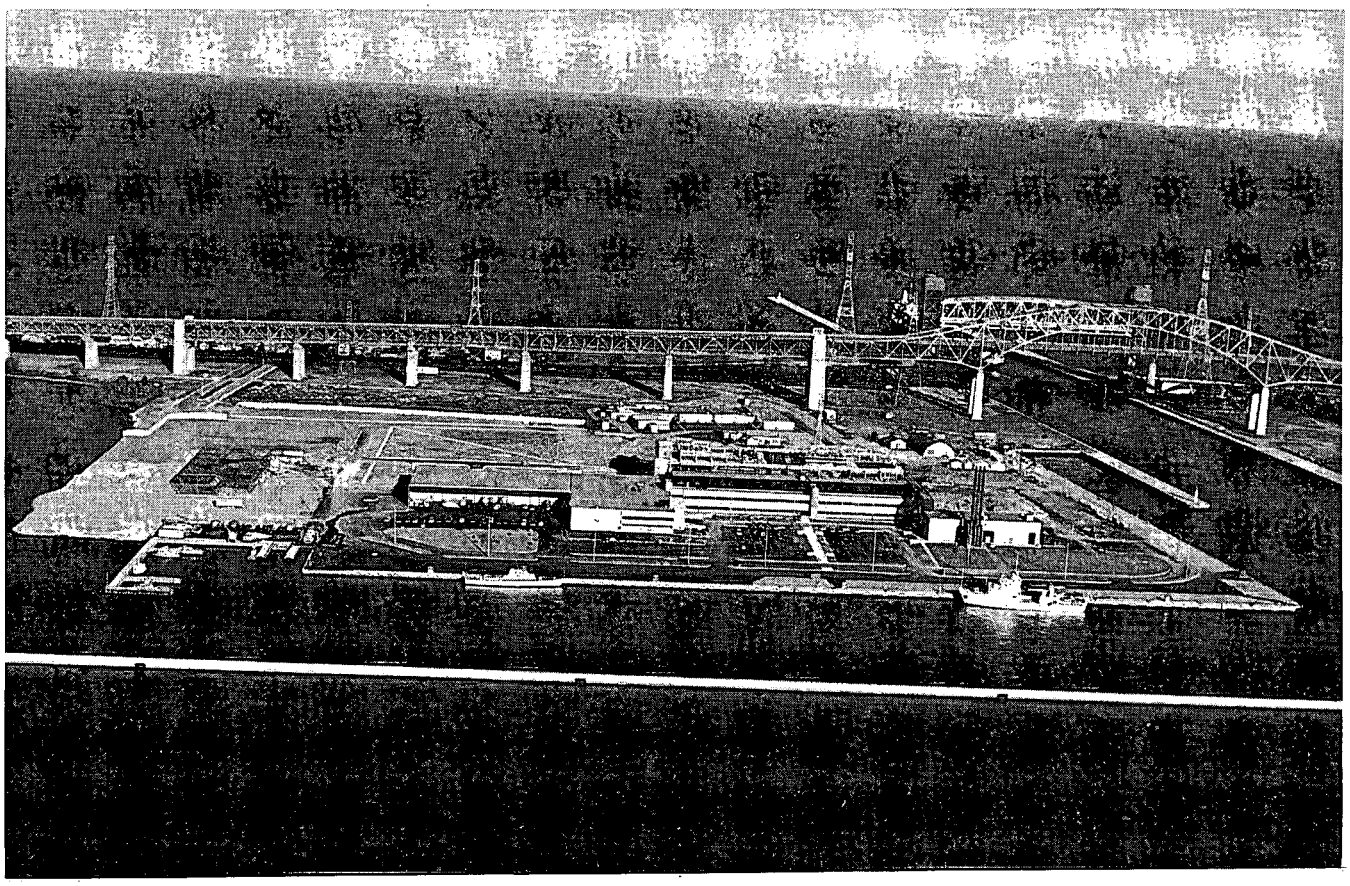
CANADA CENTRE FOR INLAND WATERS – 1970



Frontispiece. CCIW permanent buildings from the West. Far left, Water Quality Pilot Plant; centre, Workshop – Warehouse – R & D Building; right, Heating and Power Plant; seven-storey main laboratory building under construction behind R & D Building.

Canada Centre for Inland Waters - 1970

During 1970, the Canada Centre for Inland Waters was responsible to the Department of Energy, Mines and Resources (Minister, the Honourable J.J. Greene). By the date of publication, responsibility for the Centre had been transferred to the Honourable Jack Davis, Minister of Fisheries and Forestry, and Minister Designate of the proposed Department of the Environment.

CANADA CENTRE FOR INLAND WATERS
DEPARTMENT OF FISHERIES AND FORESTRY
BURLINGTON, ONTARIO, MARCH 1971

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INFORMATION CANADA
OTTAWA, 1971

Contents

ERRATA

pp. 7 and 8 Figure 2 (a) and Figure 2 (b)

A. Surface Temperature °C.

B. Surface Chlorophyll *a* mg/m^3.

C. Surface Primary Production $mgC_{ass}/m^3/hr$.

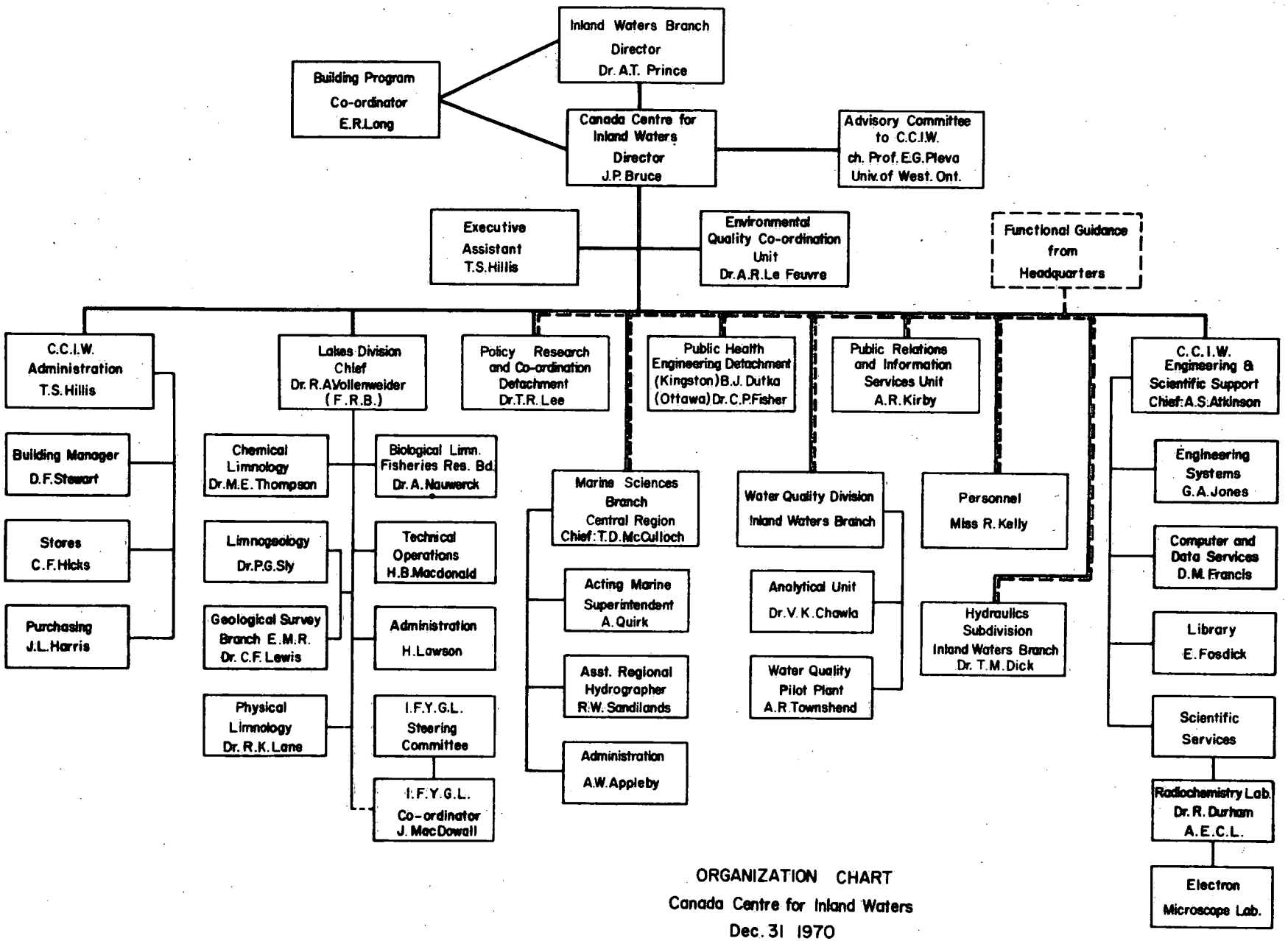
D. 0 - 50 m Net Plankton loss on Ignition mg/m^3.

p. 12 *hot-film anemombers* should read *hot-film anemometers.*

p. 14 Figure 8 should read figure 9.

p. 15 Figure 9 should read figure 8.

p. 40 *specification electrodes* should read *specific ion* electrodes.



ORGANIZATION CHART
Canada Centre for Inland Waters
Dec. 31 1970

Highlights 1970

The year 1970, the third full year in the life of the Canada Centre for Inland Waters, was an extremely eventful one. The activities and achievements of the Centre in 1970 are described in this report, and the more significant of these events listed in this opening section.

Completion of First Permanent Buildings

On November 20, the Minister of Energy, Mines and Resources dedicated the Centre's first permanent buildings (Figure 1). The buildings, which include the workshop, warehouse, research and development building and the heating plant, were completed close to schedule at a cost less than 1% above the $4 million construction budget.

The Water Quality Pilot Plant, designed to test the performance of new waste-treatment methods on a pilot plant scale, was closed in by the end of the year and should be in operation by June 1971. The reinforced-concrete frame of the seven-storey main laboratory building was completed to the fifth-floor level at year's end; the building should be ready for occupancy early in 1972. Plans for the Hydraulics Laboratory Building were completed and construction is scheduled to begin in April 1971.

Staff Appointments and Organization

A number of important staff changes took place in 1970. J.P. Bruce, Chief of the Great Lakes Division and Acting Director of the Centre, was appointed Director of the Canada Centre for Inland Waters on May 12. Great Lakes Division was renamed Lakes Division to reflect the countrywide scope of its activities and the post of Chief of the Division was taken over by Dr. R.A. Vollenweider, on secondment from the Freshwater Institute of the Fisheries Research Board. Dr. Vollenweider was formerly Head of the Fisheries Research Board detachment at the Centre. With this appointment, the FRB staff work on biological limnology became a responsibility of the Lakes Division and Dr. A. Nauwerck was appointed Acting Head of the FRB unit.

In early October, A.S. Atkinson, formerly of Atlantic Oceanographic Lab., Bedford, N.S., assumed responsibility for the Engineering & Scientific Support Division which includes Engineering Systems Section, Computer & Data Services, Common User Scientific Laboratories and the Library. Through an agreement with Atomic Energy of Canada Limited, Dr. R. Durham of the AECL staff was appointed to CCIW with responsibility for development and management of the new radiochemistry laboratory.

Transfer of Central Region, Marine Sciences Branch

During the summer, the staff of the Central Region of Marine Sciences Branch, numbering about 100 members, was transferred from Ottawa to the Centre. The Central Region has two major responsibilities. One is to undertake hydrographic charting of navigable waters from the mouth of the St. Lawrence River to the Saskatchewan-Alberta border. The second is to maintain and operate the fleet of vessels and launches used for the hydrographic surveys and for the scientific programs of the CCIW.

NTA Evaluations

CCIW played a major part in conducting and co-ordinating a joint Canada-U.S.A.-Sweden evaluation of the potential environmental impact of NTA, the substance most likely to replace phosphates in detergents. Dr. Y.K. Chau's work at the Centre demonstrated the capability of NTA to return trace metals to the waters. The trace metals involved include copper, zinc and mercury, deposited in the sediments of polluted areas such as Hamilton Harbour. Dr. A. Lerman and Dr. C.W. Childs developed mathematical models to predict the concentrations of NTA and various NTA metal complexes in the water environment.

At year's end, these and other results were combined with U.S. public health preliminary findings concerning the tendency of NTA, at high concentrations, to increase the deleterious effects of the metals cadmium and mercury in producing birth defects in rodents. The latter findings suggest the need for caution in the use of NTA pending further investigations. As an outcome of the three-nation experience with NTA evaluations, plans were laid for development of a general program of tests to which all potential pollutants entering the environment in significant quantity should be subjected.

Mercury Pollution

A survey program to determine the extent of mercury contamination of the sediments and waters of the Great Lakes was developed. This program is designed to complement surveys of the mercury content of fish, conducted by the Freshwater Institute of the Fisheries Research Board and by Ontario Government agencies. Maps showing mercury distribution in the sediments of Lake Ontario and Lake St. Clair were completed before the end of the year and similar maps of Lake Huron and Lake Erie are in course of preparation. The Lake Ontario map showed disturbingly high concentrations off the mouth of the Niagara River. By dating the layers of a core from Lake

Figure 1. Dedication ceremony for new buildings at CCIW. Left to right: Hon. George Kerr, Minister of Energy and Resources Management, Ontario; Dr. J.R. Weir, Chairman, Fisheries Research Board of Canada; Mayor George Harrington, Town of Burlington; Mr. R.E. Tait, Chief, Public Health Engineering Division, Dept. of National Health and Welfare, Canada; Hon. J.J. Greene, Minister of Energy, Mines and Resources, Canada; and Mr. J.P. Bruce, Director, Canada Centre for Inland Waters.

Ontario, it was possible to compare the level of mercury in industrially-contaminated sediments with the natural background levels of mercury which existed prior to 1900.

Dr. R.L. Thomas, who supervised this work, was consulted frequently by provincial and federal agencies on a number of associated problems, including the possibility of dredging mercury-laden sediments. Dr. Y.K. Chau published details of a very sensitive chemical analytical method for determining mercury in water and supervised a program for analyses of lake and rain waters.

Toxic Substances

To anticipate likely problems of a serious nature concerning environmental toxic substances, biologists, chemists and others at the Centre prepared a list of 18 potential pollutants. As a first step, economic geographers in the Resources Research Unit are undertaking surveys of industrial and other uses of these substances to help direct environmental monitoring programs to areas where problems are most likely to occur. Surveys of the substances most likely to cause problems – PCB's, cadmium, zinc, and lead – are underway in Great Lakes waters, sediments and biota.

Contingency Plans

Two staff members of the Centre (F.M. Boyce and A.R. LeFeuvre) provided technical assistance to the Ministry of Transport in the early stages of the ARROW oil spill disaster in Chedabucto Bay, Nova Scotia, in February.

A federal interdepartmental contingency plan for oil spills was approved, under the terms of which CCIW is responsible for co-ordinating federal operations on the Great Lakes. The technical Field Manual for clean-up of spills of oil and toxic materials, prepared by an interdepartmental working group chaired by Dr. LeFeuvre, was in press at year's end.

Project Hypolimnion

A major field program co-ordinated by Dr. N.M. Burns and directed towards obtaining more complete information on the causes, effects and extent of oxygen depletion in the bottom waters of Lake Erie, was carried out in the central basin in collaboration with the U.S. Federal Water Quality Administration.

The study showed that the tremendous algal blooms which occurred used up all the available phosphorus in the surface waters, and on sinking to the bottom and decaying rendered an area of more than 1000 square miles of bottom waters completely devoid of oxygen. It was found also that significant regeneration of phosphates from the decaying algae and from sediments occurred in the anoxic area, but that this was not the case if measurable dissolved oxygen concentrations were present.

U.S.–Canada Great Lakes Pollution Abatement

The International Joint Commission held six public hearings early in 1970 to receive submissions and hear argument based on the 1969 Report of the Advisory Boards on Pollution of the Lower Great Lakes. CCIW staff members attended the hearings and in several cases presented evidence. The IJC issued an interim report in the spring supporting a number of the recommendations of the Advisory Boards.

In June, a meeting of Canadian cabinet ministers and their U.S. counterparts established a joint working group and a number of sub-groups to work out detailed Canada-U.S.A. agreements. CCIW is represented on the sub-groups on water quality criteria and abatement programs (R.A. Vollenweider), contingency plans (A.R. LeFeuvre), research co-ordination (J.P. Bruce – Co-Chairman), and special situation communications (T.R. Lee). Much of the work of these sub-groups was completed by the end of the year. Another meeting of ministers is expected to take place in 1971.

Advisory Committee to Canada Centre

Dr. E.G. Pleva, University of Western Ontario, was re-elected chairman of the Advisory Committee to the Canada Centre. The Committee reviewed CCIW programs and provided advice on program development. Working groups on water research grants and contracts to the private sector (Chairman, J.F. MacLaren), university participation and occupation of space at CCIW (Chairman, Dr. Pleva), and water quality pilot plant (Chairman, A.R. Townshend) were active during the year. In November, ACCC established a working group to advise on development of hydraulics programs.

Appendix D lists the members of the Advisory Committee and the Working Groups.

Department of the Environment

In late 1970, the Government announced its intention to establish a Department of the Environment based in part on the Department of Fisheries and Forestry, and incorporating the Water Sector of the Department of Energy, Mines and Resources, the Meteorological Service of the Ministry of Transport, portions of the Environmental Health Centre of the Department of National Health and Welfare, and several other units. On the basis of the discussions which have been held regarding the organization of the Department of the Environment, it is clear that all components of the Canada Centre for Inland Waters will form part of the new department. There is no doubt that a Centre administered entirely by a single department will offer a greater degree of efficiency in the use of administrative and support services and a higher level of co-ordination in program planning than could be expected from the multi-departmental form of organization with which CCIW started 1970.

Lakes Division (Inland Waters Branch)

CHEMICAL LIMNOLOGY SECTION

Activities during 1970 were dominated by two large and equally urgent projects – the necessity to understand better the possible consequences to the environment of possible widespread use of NTA (nitrilotriacetate) in laundry detergents, and the need to acquire quantitative information on the accelerating deterioration of the quality of Lake Erie waters, especially during late summer when a large area of the bottom water is devoid of oxygen. Both projects required a much increased number of contacts and exchange of information with scientists at other water research centres, in Canada, U.S.A., and Sweden.

Other projects conducted in the Section include a program to monitor rain chemistry on the Canadian side of the Great Lakes; a study of the physical chemistry of aqueous chloride-sulphate solutions, and combination of these data with published analyses of natural brines to construct models of the natural evolution of such brines; construction of geochemical models of rates of formation of steady-states in lakes, of rates of transport of chemical species across the sediment-water interface, and of the distribution of nuclear-fallout in the Great Lakes, and planning a chemical program for Lake Okanagan.

An organic chemist, Dr. W.M.J. Strachan, joined the Section in August, and a post-doctoral research fellow, Dr. J.O. Nriagu, came in September. Dr. Nriagu is an economic geochemist and is concerned with chemical equilibria in lake sediments.

Chemical Monitor Cruises

The Chemical Limnology Section is responsible for the planning and the evaluation of the results of the chemical monitor cruises on the Great Lakes. The samples are collected by personnel of the Technical Operations Section, Lakes Division, and analyzed by staff of the Water Quality Division. Several concurrent research projects of other units at the CCIW make use of the cruises or the data from the cruises. The contract arranged in 1969 with Prof. J.R. Kramer of McMaster University to develop computer programs to facilitate retrieval and analysis of the cruise data, was continued during 1970, and now all of the STAR cruise data for Lake Ontario and Lake Erie from 1966 to present are "cleaned-up" and available for retrieval, sorting, and statistical testing by a variety of computer programs.

A full year of monitor data was accumulated for Lake Ontario for monthly cruises starting in April 1969 and ending in March 1970.

Lake Erie was monitored intensively during 1970, with nine cruises during the period April to December. Ice on Lake Erie prevents cruises during January, February and March.

Two special programs were conducted during 1970 to amplify the information obtained by routine cruises. The first, in May, was a study of the chemical effects of the thermal bar in western Lake Ontario – see Project In Situ, below. The second was a special study of conditions in the Central Basin of Lake Erie during August – see Project Hypolimnion, below.

Project In Situ

This project was undertaken to study the effects on the chemistry of the lake water of the "thermal bar", a phenomenon which persists for a month or so in Lake Ontario during the spring warming period, and which may be defined as the region where the thermocline of the warmer inshore water becomes vertical and meets the colder, isothermal, off-shore water. Stations on either side of the "bar" were monitored for several short time series – 24 to 36 hours, for a number of chemical parameters, including nutrients, some major ions, and trace metals. Preliminary evaluation of the data shows a statistically significant separation by the "bar" of two chemically distinct bodies of water, especially with respect to nutrients.

Project Hypolimnion

In December of 1969 a joint project by the Canada Centre for Inland Waters and the U.S. Federal Water Quality Administration, Lake Erie Basin Office, Cleveland, Ohio was conceived to study the extent and mechanisms of oxygen depletion in the central basin of Lake Erie. Much comment and criticism from the staff of CCIW and the Freshwater Institute, Winnipeg, was received and the final plan was formulated in close conjunction with FWQA scientists in March 1970. Dr. N.M. Burns of Chemical Limnology Section acted as project co-ordinator and organizer for the input from CCIW. Mr. Curtis Ross organized the input from the FWQA.

It was decided that current meters, winds recorders and thermographs from the FWQA were to be used to monitor water movements in the basin. The C.S.S. Limnos would be used to survey 24 chemical parameters at 25 stations and

temperature profiles at 41 stations across the basin every 4 days. Bacterial and biological processes were to be investigated at 5 major stations using the launch C.S.L. AGILE. The project was finally carried out much as it was planned with some parts of the program being even more successful than was hoped for.

In all 7 basin surveys were carried out. A number of the scientists were scuba divers who observed and photographed a very interesting sequence of changes on the sediment surface. Also, divers carrying short pieces of plastic core liner (about 1 ft. long) were able to take sediment-water interface samples for bacterial and other analyses. The co-operation between the scientists from the two countries was very effective and free of any difficulties.

The pattern of oxygen depletion was clearly observed with anoxic conditions first appearing in the western end of the basin and then progressing eastward as the summer continued. By the end of August 1970 1000 sq. miles of the basin was anoxic with the oxygen depletion causing large-scale nutrient regeneration.

The mechanisms of oxygen depletion are still to be extracted from the data together with analyses of other nutrient, biological and bacterial interactions.

NTA Studies

Early in the year it became apparent that NTA (nitrilotriacetate) might be introduced in the environment in large quantities if it were used widely as a substitute for polyphosphates in laundry detergents, yet very little was known about the possible effects of NTA in lake waters. It was clear that the first requirement was for a reliable analytical method. The Microtek gas chromatograph, which was intended to be used in the separation and identification of soluble organic compounds from lake water, was used instead to detect the propyl ester of NTA, after development of a pre-concentration step by anion exchange resin. The method, which can also be used to determine EDTA in lake water, is lengthy and is only used for analyses where high accuracy and sensitivity are required.

In other early experiments, not NTA but its effects were studied. It was decided to test the extent to which a reaction like

$$Pb_3(PO_4)_2 + 3NTA^{\equiv} \rightarrow 3PbNTA^{-} + 2PO_4^{\equiv}$$

would go to the right, which could be studied by permitting NTA to react with solid metal phosphates and then monitoring the solution levels of metal and orthophosphate. Tube studies in Hamilton Harbour indicated that there was positive release of metals from the sediments by NTA, but the phosphate levels varied without an obvious relationship to the NTA. Orthophosphate is an extremely labile and biologically active substance in the ecosystem, and a lack of correlation is not unexpected.

Laboratory studies on NTA-sediment interactions also indicated release of metals, particularly zinc and iron.

A computer program, available in the literature, was used to calculate the chemical forms of nitrilotriacetate in solutions approximating lake water in composition. In particular, the distribution with respect to various heavy metals, to more abundant species such as Ca, Mg and Na, and to competing ligands, was evaluated. The results showed that at lower concentrations of NTA (<0.4 mg/1), $cuNTA^{-}$ would be the principal NTA species present.

Rain Chemistry Project 1970

The sampling network of the Rain Chemistry Project (see Annual Report 1969) was expanded in 1970 and now comprises a total of 15 stations in the Canadian Great Lakes region. There are now 8 stations in the Lake Ontario basin, 3 stations in the Lake Erie basin, 2 stations in the Lake Huron basin and 2 stations in the Lake Superior basin. The final sampling site was installed in July 1970. All 15 sampling sites are equipped with the bulk precipitation type of sampler.

Another type of precipitation sampler has been installed at the site of the Canada Centre for Inland Waters research complex. This sampler collects only rainfall, opening automatically at the start of rain and closing on the cessation of rain. The automatic action of this sampler can be reversed so that it acts as a dry-fallout or dust collector. It is hoped that the information obtained from this apparatus will augment that from the bulk precipitation (rainfall plus dry fallout) samplers and help us to better understand the chemical nature of precipitation.

Physical Chemistry of Aqueous Solutions

We are continuing an experimental program designed to collect activity coefficients of multicomponent salt solutions which resemble natural brines.

We are now making, or have made, measurements on the following systems over the temperature range from 0° – 25°;

$H_2O - NaCl - Na_2SO_4$
$H_2O - NaCl - K_2SO_4$
$H_2O - KCl - Na_2SO_4$
$H_2O - KCl - K_2SO_4$
$H_2O - Na_2SO_4 - K_2SO_4$

The only major change in our study of mixed salt solutions is that emphasis is now being placed on measurements in the temperature range down to the freezing point of aqueous solutions. Some measurements at 25° are still being completed but we probably have enough information now to estimate solubilities in mixed salt solutions at this temperature, and it is more important to determine how activities and solubilities vary with temperature.

We are also making preliminary measurements to assess the isopiestic method described by Kirkintsev (Russ. J. Inorg., Chem *13*, 600 (1968)) of measuring solubilities in mixed salt solutions.

Geochemical Models

Work on geochemical models centered around two classes of processes:

(i) How fast chemical steady-states may be attained in stratified and unstratified lakes, and in the oceans, after the existing chemical and physical conditions in the environment have been changed;

(ii) Transport of dissolved matter across sediment-water interface.

The study of (i) showed that chemical steady-states in lakes should be re-established within, at the most, a few years to tens of years, depending on the water residence time in the lake and the rates of chemical reactions. For a relatively rapidly degrading species (half lives measured in days or months) the final steady-state concentrations in lakes of intermediate and large size would be very low compared with the concentration in inflow.

In (ii) a study has been done of migration of dissolved species out of the sediment, due to continuous dissolution of detrital minerals in two of the Kenora lakes. The chemical flux out of the sediment amounts to as much as 15-30 percent of the total dissolved solids budget of the lakes. The rates of dissolution of minerals within the sediment are of the order of magnitude comparable to the rates of sedimentation, the latter presumably compensating for the partial dissolution.

In Lake Ontario, migration of sodium and chloride from the lake water into the sediment has been explained as a diffusional process. The total amounts of sodium and chloride accumulated in the sediment during the last 60-50 years are very small compared to the total amount of salt which has passed through the lake. The conclusion is, therefore, that the sediment has only a negligibly small effect on the removal of sodium and chloride from lake water.

A mathematical model has been developed for computing the Strontium-90 (half-life 29 years) concentration in the five Great Lakes simultaneously. The computed concentrations for the period 1954-1960 are in a reasonably good agreement with the analytical data on Sr-90 in the Great Lakes. Migration of the nuclear fallout products, Sr-90 and Cesium-137, into the sediments of Lake Superior and Lake Ontario is primarily a diffusional process: the two radionuclides diffuse from the lake into the interstitial water and they are being taken up by the sediment particles. The uptake of Sr-90 and Cs-137 by the lake sediments has a very small effect on the concentrations in lake water. This picture is in principal similar to the small effect of the sodium and chloride diffusion into the sediment.

Geochemistry of Brines

Work on the chloride-rich brines has been completed with good results. At the present state of the art it is possible to predict a stage in the process of brine concentration at which sodium chloride begins to precipitate. The general thermodynamic model applies to a wide variety of brines in which the main and dominant anion is chloride. Realizing the importance of chloride-sulphate type brines in the Prairies, work has been started on the chemical behaviour and evolution of chloride-sulphate waters in nature. The necessary thermodynamic data on aqueous solutions and chemical analyses of natural brines are being collected and considered for the purpose of arriving at a predictive model which should describe the course of evolution and precipitation of minerals in chloride-sulphate brines.

Okanagan Studies

A chemical program for the five Okanagan lakes (Okanagan, Skaha, Osoyoos, Kalamalka, Woods) has been prepared. The program is aimed at obtaining a variety of chemical data during the 1971 sampling operations season. The field and laboratory chemical data will be used in the evaluation of chemical budgets of the lakes and elucidation of some of the more important chemical processes, the understanding of which is required in the longer range planning of the water quality and resources utilization.

BIOLOGICAL (FISHERIES RESEARCH BOARD)

The FRB Detachment represents the biological section of the Lakes Division of CCIW. Its main objectives are three: (1) to monitor and analyze spatial and temporal distribution of organisms in the Great Lakes; (2) to conduct laboratory and field experiments on the relationship between organisms and different environmental factors, especially the factors which are related to eutrophication and water pollution; (3) to develop methods for monitoring

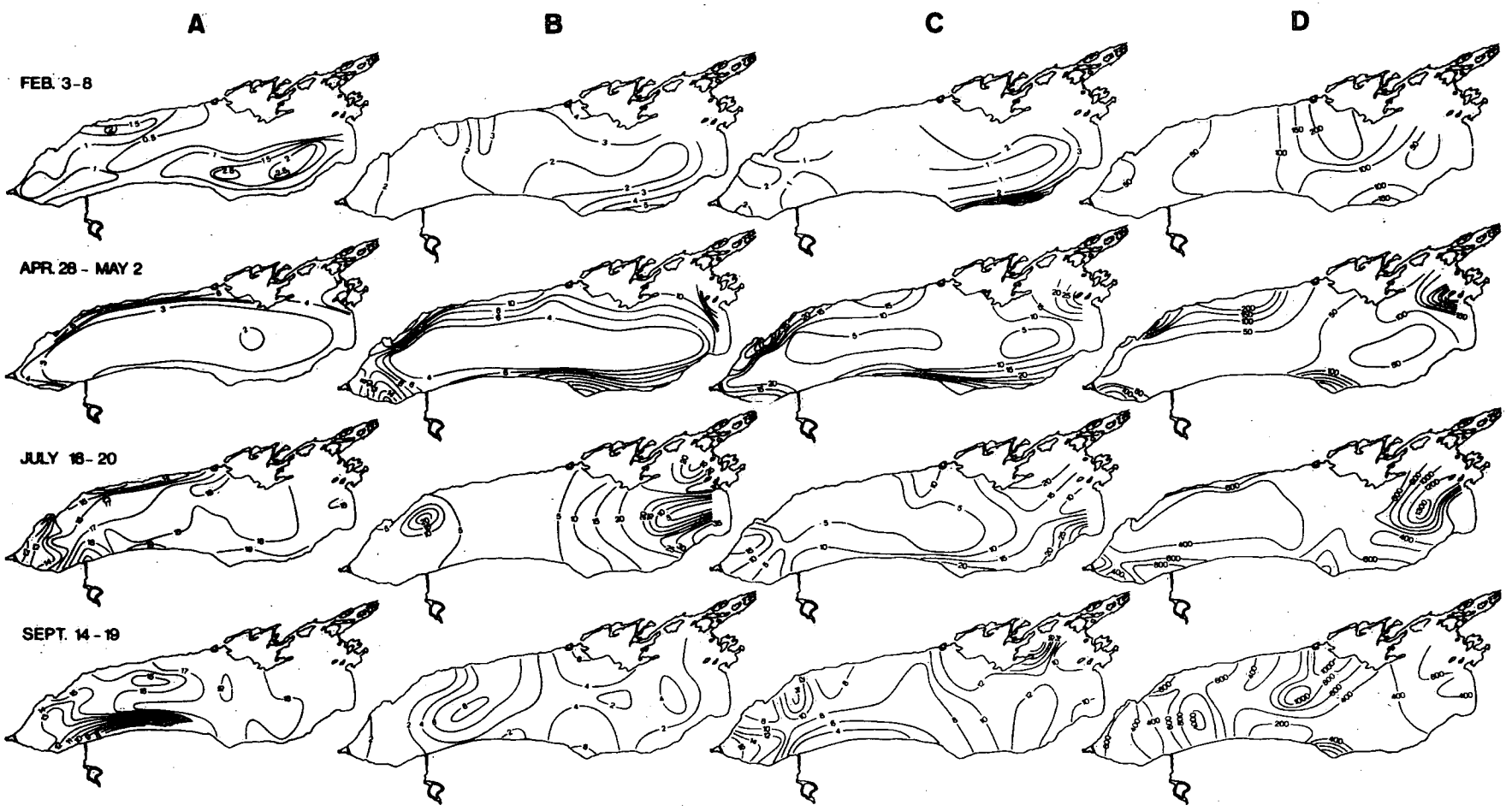


Figure 2(a).

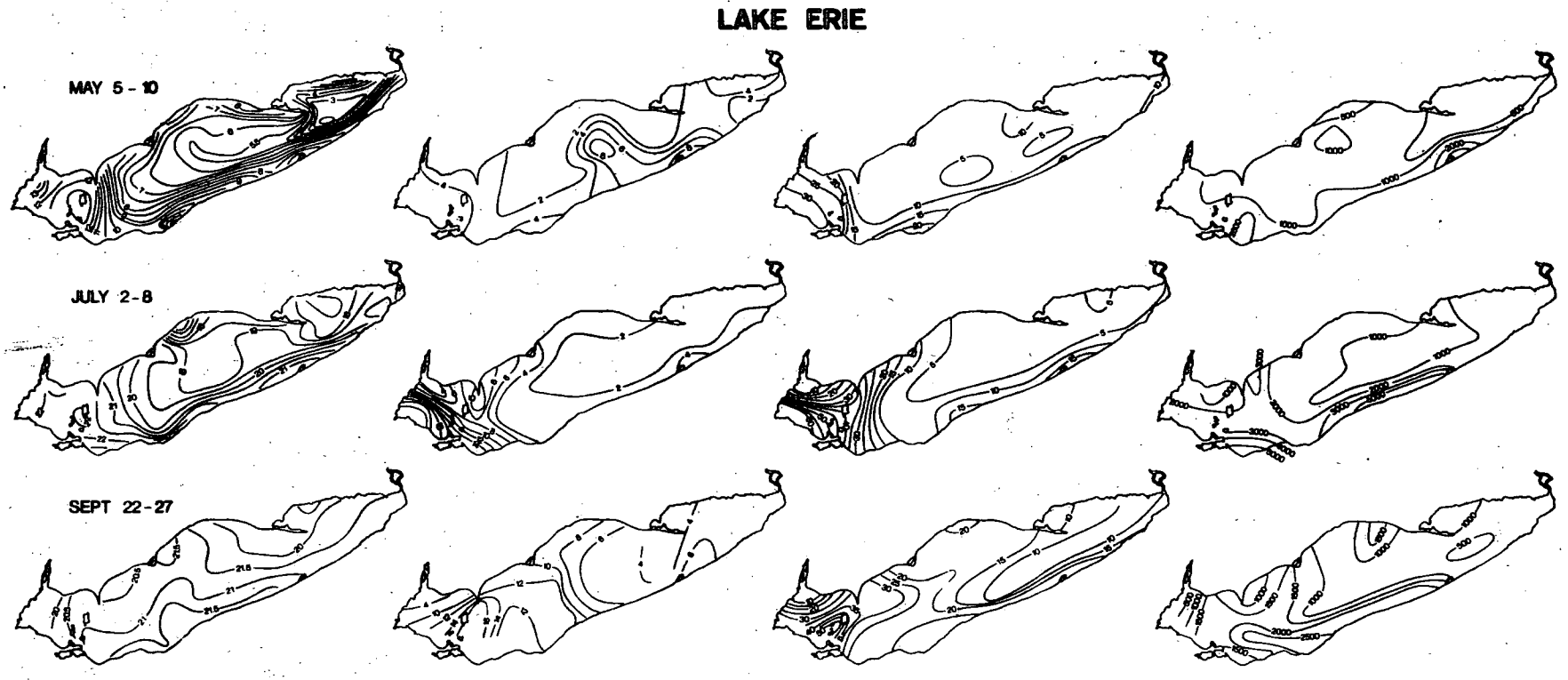


Figure 2(b).

biological features which are not yet accessible to automatic analysis.

Monitor Cruises

In 1970, FRB participated in 13 monitoring cruises on Lake Ontario (January to December), 10 cruises on Lake Erie (April to December), and 2 summer cruises to Lake Huron, Lake Superior and Georgian Bay. From a total of approximately 70 stations, 686 samples were taken for phytoplankton enumeration, 910 samples for zooplankton enumeration, 701 samples for determination of total biomass, 646 samples for determination of plant pigments, and 615 samples for estimation of primary production. Further, 565 bioassays were performed on shipboard to study stimulation and inhibition by nutrients and trace metals. In addition, chlorophyll was determined by continuous *in situ* fluorometer measurements for all cruises.

Figure 2 shows the development of some parameters as measured by the monitoring program in Lake Ontario and Lake Erie, 1970.

In Lake Ontario, chlorophyll starts to build up in shallow inshore areas in spring. Later, it spreads offshore into the lake, and its highest concentrations appear in the eastern parts of the lake in late summer. A similar picture has emerged for Lake Erie, but here the maximum usually remains in the shallow western basin of the lake.

Primary production is closely related to chlorophyll content, but characteristic differences exist between Lake Ontario and Lake Erie. While chlorophyll concentrations are similar in the two lakes (summer average 5 - 6 mg Cl_a/m^3, summer maximum about 40 mg Cl_a/m^3), primary production is about two times higher in Lake Erie (Ontario 10.5 mg C_{ass}/m^3h, Erie 21 mg $C_{ass}/m^3/h$).

The loss on ignition in the net samples (dry weight minus ash weight) roughly expresses the total biomass of zooplankton. In both lakes, its distribution is characterized by a strong patchiness but also by a striking constancy of the general distribution pattern. A time-lagged relationship between primary production and zooplankton biomass, and a strong correlation between temperature and zooplankton growth can be observed. Zooplankton biomass reaches 2 - 3 times higher values in Lake Erie than in Lake Ontario.

Taxonomy

The species list of phytoplankton, zooplankton and bottom fauna of the lakes is being continuously updated. The main effort in 1970 was put into the identification of plankton of Lake Ontario. Altogether, 350 species of phytoplankton were found in this lake. Only 70 of these were recorded earlier. Several species, mainly rotifers, were added to the zooplankton species list.

Plankton Distribution

Phytoplankton and zooplankton horizontal distributions were studied by means of microscopic examination of the samples. Distribution maps were prepared for all important species on Lake Ontario. Zooplankton distribution in Lake Huron and Lake Superior has been studied by Dr. K. Patalas, Freshwater Institute, Winnipeg. A preliminary report on zooplankton in Lake Ontario, Lake Erie and Lake Huron has been prepared by him.

Bottom Fauna

A project was started on bottom fauna distribution in the strongly polluted Hamilton Harbour. The aim of this study is to detect interrelationships between degree of pollution and community structure. Samples are taken from different types of sediment at all times of the year, and the bottom fauna are analyzed qualitatively and quantitatively and compared with the physical and chemical properties of the mud. At the same time, haemoglobin properties of selected groups of animals are being studied for comparison with different oxygen tensions.

Pigment Studies

Besides the routine determinations of chlorophyll *a*, on the monitoring cruises, pigment measurement techniques were evaluated and improved. Work was also done to separate and identify chlorophyll degradation products, and the temporal and spatial distribution of chlorophylls *a, b, c,* and their degradation products phaeophytin and phaeophorbide were mapped. The relationship between chlorophyll and the degradation products was shown to be an excellent key to understanding water mass history and movements.

Enrichment Studies — Bioassays

The aim of this project was to study the effects of nutrient enrichment and other chemical substances on photosynthesis and growth of natural phytoplankton associations, P, N, C, Fe, Si, K, Mo, Co and Mn were used, separately or in combinations, in a series of experiments with different concentrations, both on shipboard and in the laboratory. The effect of NTA was tested in the same way, but no significant result was found. Carbon was never found to be limiting alone, but could, in some cases, stimulate photosynthesis when given together with phosphorus (Figure 3). Of the other substances, manganese showed the strongest positive effects, but responses were not consistent, being at times positive, negative or negligible under seemingly identical conditions. These results reflect the complexity of the chemical micro-environment. The

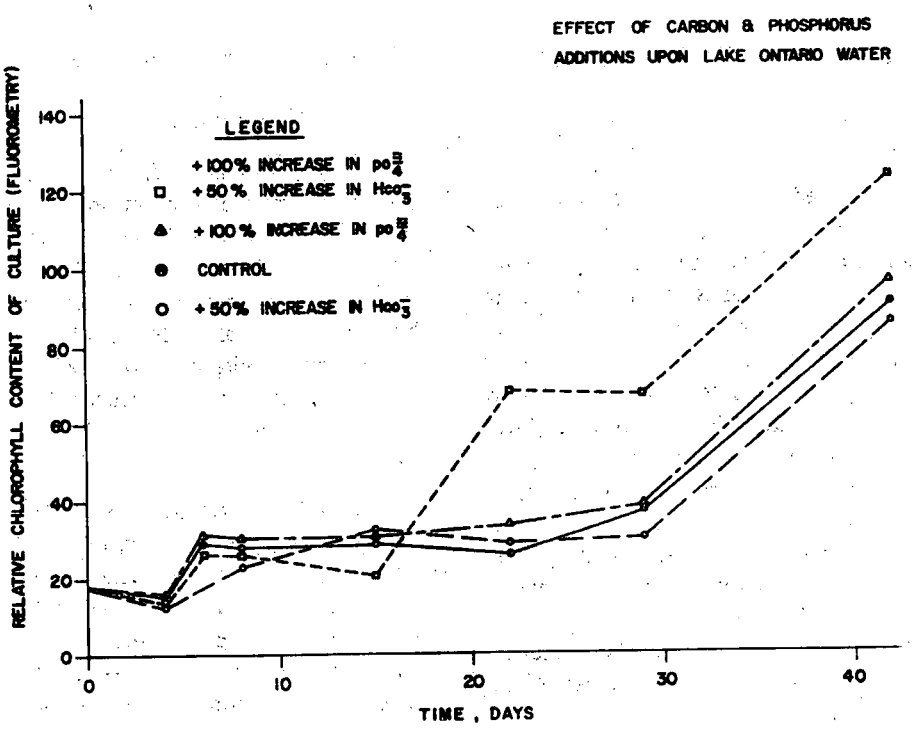


Figure 3. Effect of carbon and phosphorous additions upon Lake Ontario waters.

importance of the accidental composition of species and their physiological state at the moment of sampling do not allow a simple interpretation of the results, and require a more sophisticated approach.

Effects of Toxic Substances on Algae

Physiology of freshwater organisms is affected by many substances entering the lake by pollution from industry and urban sewage. Pesticides and heavy metal compounds have been demonstrated to have deleterious effects on many organisms even in very small amounts.

Experiments were started to study the inhibitory effects of DDT, dieldrin and other chlorinated hydrocarbons, organic mercurial, and polychlorinated biphenyls on the growth and metabolism of algae. The C14-technique, cell counts and pigment analyses were used in the study. Preliminary results show inhibition of phytoplankton productivity at a concentration of 1 ppb of DDT and dieldrin (Figure 4).

Diurnal Variations of Biological Parameters

Sampling on monitor cruises is restricted to surface or epilimnetic waters and time of sampling has not usually been considered. Short time changes in biomass and biomass composition caused by water mass movements, migration of organisms, cycles of metabolic processes related to day/night rhythms, etc., may, however, have considerable significance.

To study these factors, 48-hour studies with continuous registrations and short-interval sampling in time and depth were done at offshore and inshore stations from an anchored ship in Lake Ontario. Considerable daily fluctuations were found in pigment composition and primary production which indicate a strong necessity for a careful interpretation of occasional experiments as well as of observations from single points on monitoring cruises.

Long Term Studies

To study and establish the long term changes of water quality and organism composition in the Great Lakes, data from recent studies have been collected and compared with previous studies. Oxygen is one important element in a lake's metabolism and a determining factor for its trophic state. Figure 5 shows how oxygen depletion in the bottom water of Lake Erie has changed since 1929.

PHYSICAL LIMNOLOGY SECTION

The Physical Limnology Section specializes in matters concerning the physics of lakes and their natural environments. In 1970, a substantial portion of the scientific program included a continuation of basic physical measurements in the Great Lakes, combined with preparations for the 1972 International Field Year for the Great Lakes

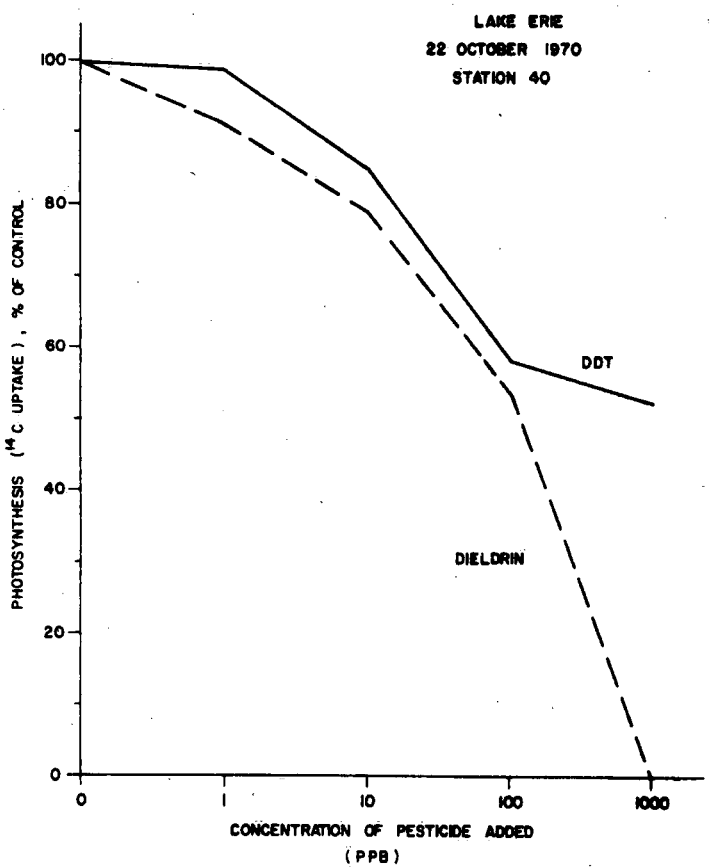


Figure 4.

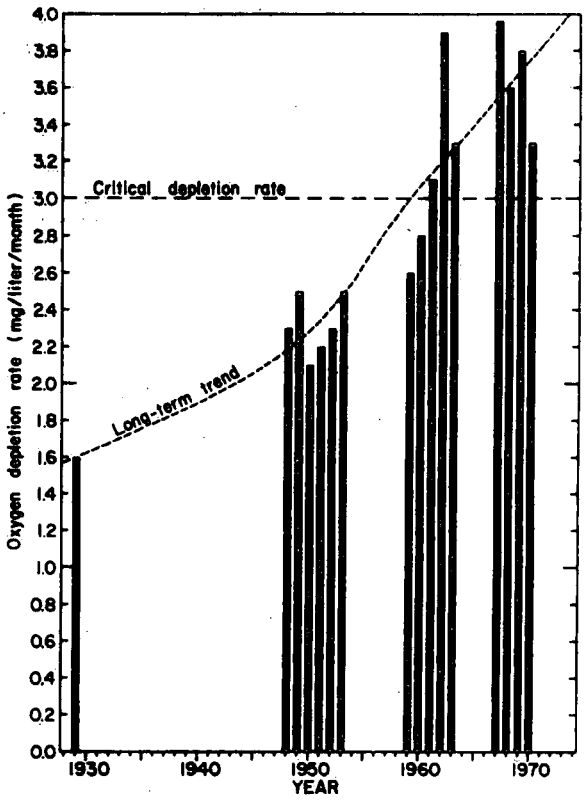


Figure 5. Mean depletion rates for dissolved oxygen during summer in the bottom water of central Lake Erie. Note that the critical rate of 3.0 mg/liter/month, reached in 1961, produces zero oxygen levels before the end of summer stratification

(IFYGL). Participation in a joint federal-British Columbia study of the Okanagan Basin was initiated and preparations were being made for the transfer of staff to the Freshwater Institute (Winnipeg) to undertake "small lakes" studies. New staff arrived late in the year to consolidate the remote sensing studies and initiate oil spill studies.

Outfall Simulation Experiment in Lake Ontario

Rhodamine B dye was released continuously in Lake Ontario, near Oshawa, 2 km offshore in 20 m deep water, 3 metres from the lake bottom from a 10 m long horizontal diffuser. The resulting plume was surveyed for 6 days at different depths and at different distances from the dye source. The measured horizontal concentration distributions were many-peaked, mostly very much wider than comparable dye plumes near the surface, and on some occasions consisted only of discrete patches of dye, hundreds of metres apart. These features of "diffusion" may be attributed to the wave-like character of flow at low residual velocity.

Coastal Current Climatology

Experimental data on coastal currents were collected during May-October, 1970 in Lake Ontario, near Oshawa, using Lagrangian and Eulerian techniques. Lagrangian velocities were measured using current-following devices (drogues) and Eulerian currents from moored and deck read-out current meters. This data will provide the basis to establish a climatology of coastal currents (near Oshawa) particularly relevant for planning locations of any sewage or cooling water outlets. Plans are underway to extend this study systematically to other coastal areas of Lake Ontario during the 1971 field season.

Small-Scale Air-Lake Interaction Studies

Studies of small scale air-lake interactions were carried out at a site offshore from Burlington. A guyed, bottom-mounted tower and a second experimental self-supporting tower were used to mount instrumentation in a water depth of 15 metres. The towers were also used in a co-operative program, by the Micrometeorological Research group, Meteorological Service of Canada.

Instrumentation for measurements of the eddy flux of

momentum, heat and water vapour were tested as a development effort for the IFYGL. These instruments included the Thornthwaite "Unit Parcel" momentum fluxmeter, two-dimensional hot-film anemombers, Lyman-alpha Humidrometer and Resistance wire thermometer. Measurement techniques were developed where sensor and transponder units were mounted on the tower and data were transmitted by cable to the recording equipment housed aboard a boat anchored nearby.

Data were successfully recorded on several days and have been only partially analyzed. The "Unit Parcel" momentum fluxmeter malfunctioned but has since been modified and is undergoing further tests. Data from the fast response sensors are not yet analyzed. Data reduction and processing techniques are being developed which will apply to the IFYGL programs.

Evaluation of the CCIW Meteorological Buoy System

The meteorological buoy system, based on the Plessey Hymet magnetic tape recorder, previously developed at CCIW, was subjected to a comprehensive field evaluation to determine accuracy and reliability under realistic operational conditions.

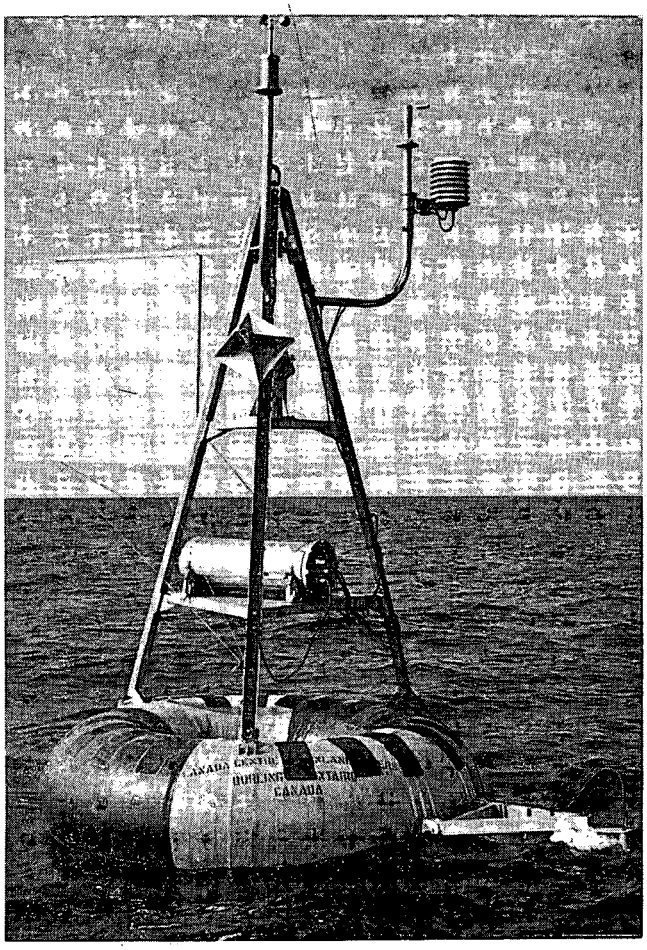


Figure 6.

The system was first evaluated for basic sensor and system accuracy through an intercomparison test with standard instrumentation at the Meteorological Research Station of Meteorological Service of Canada.

A second series of tests were conducted during July and October with the system deployed on buoys in Lake Ontario (Figure 6). During the later period, similar measurements were conducted on a Bedford Stable Tower provided near the buoy location by the Department of Transport. These measurements provide a set of data from which influences of buoy motion on system accuracy are being evaluated.

Preliminary analysis of the data from the comparison program has been completed. Results indicate that acceptable accuracies were obtained in the land-based tests. The marine environment has caused some equipment failures. The total degree of degradation of data accuracy for buoy-mounted systems is not yet determined.

In order to evaluate the feasibility of including buoy-mounted solarimeters in the IFYGL core network, two periods of intercomparisons of buoy-mounted solarimeters with tower-mounted instruments were conducted. The first, during July, suffered from a lack of rough conditions. The data from the gimbal-mounted buoy solarimeter was consistently high, with daily totals by from less than 3% up to 9%. The second period, during early October, enjoyed a wider variety of conditions but experienced greater instrumentation difficulties.

Thermal Characteristics – Instrumentation and Measurements

The towed thermistor array which was tested briefly in 1969 was completed and fully tested in 1970. This device measures water temperatures at 13 points along faired cable and records them as functions of time. The cable may be towed at speeds up to 6 knots. The 1970 program yielded data sufficient to assess the performance of the equipment and to indicate improvements needed to develop the experimental version into an operational system.

Another temperature profiling system, developed at the Atlantic Oceanographic Laboratory, Bedford Institute, Halifax, was tested along with the CCIW array. This system, known as the Batfish, consists of a towed body carrying a temperature and depth sensor which can be controlled from the ship and made to undulate between pre-selected depths. This system is potentially useful for Great Lakes research.

Generally speaking, the towed array is suited to detailed surveys where the scales of horizontal variation are less than 500 m. Examples of the phenomena which fit this category

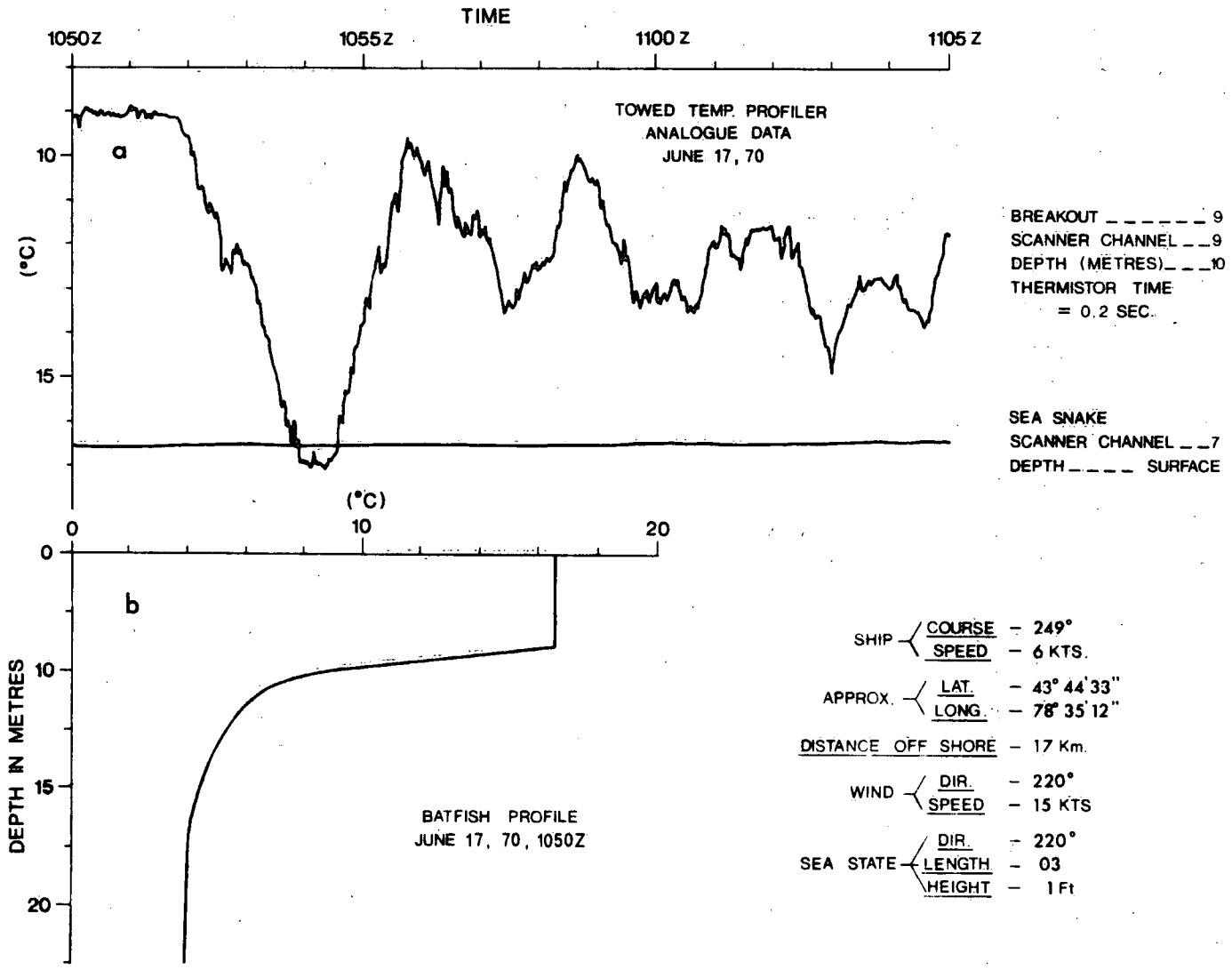


Figure 7. Example of a train of internal waves encountered off Oshawa in July 1970. (a) shows uncorrected analogue records of the surface and 10m temperature. (b) shows the temperature profile as measured by the Batfish at 1050Z. The vertical movement sufficient to cause the large increase in the 10m temperature is about 2.5m and the wavelength of the disturbance (neglecting Doppler shifts) is about 550m.

are short period internal waves (Figure 7) and turbulence, thermal plumes (heated effluents or river discharges), and the spring "thermal bar". The undulating system has a typical wave length of 1 km and therefore is suited to large scale phenomena and to lake-wide surveys. The system can be towed at 10 knots or more and the data recording requirements are less severe than for the multi-channel array. The Batfish and the array can be used together on the same ship. The combination is very powerful and yields data that may offer insights as to how large and small scale phenomena are linked.

The 1970 instrument testing program was designed also as a scientific experiment and produced data which reveal a great complexity of thermal structure. Preliminary analysis suggests that the shore regions of a stratified lake may be zones of considerable vertical mixing under appropriate conditions despite the stability afforded by the stratification.

Thermal Bar Study – Lake Ontario

Two vessels, the SURGE and the RADEL, were equipped with towed thermistors for the purpose of tracking the surface manifestations of the thermal bar off Oshawa. The principle objective of the study was to ascertain the integrity of the thermal bar over distances of several kilometres. The surface data obtained were supple-

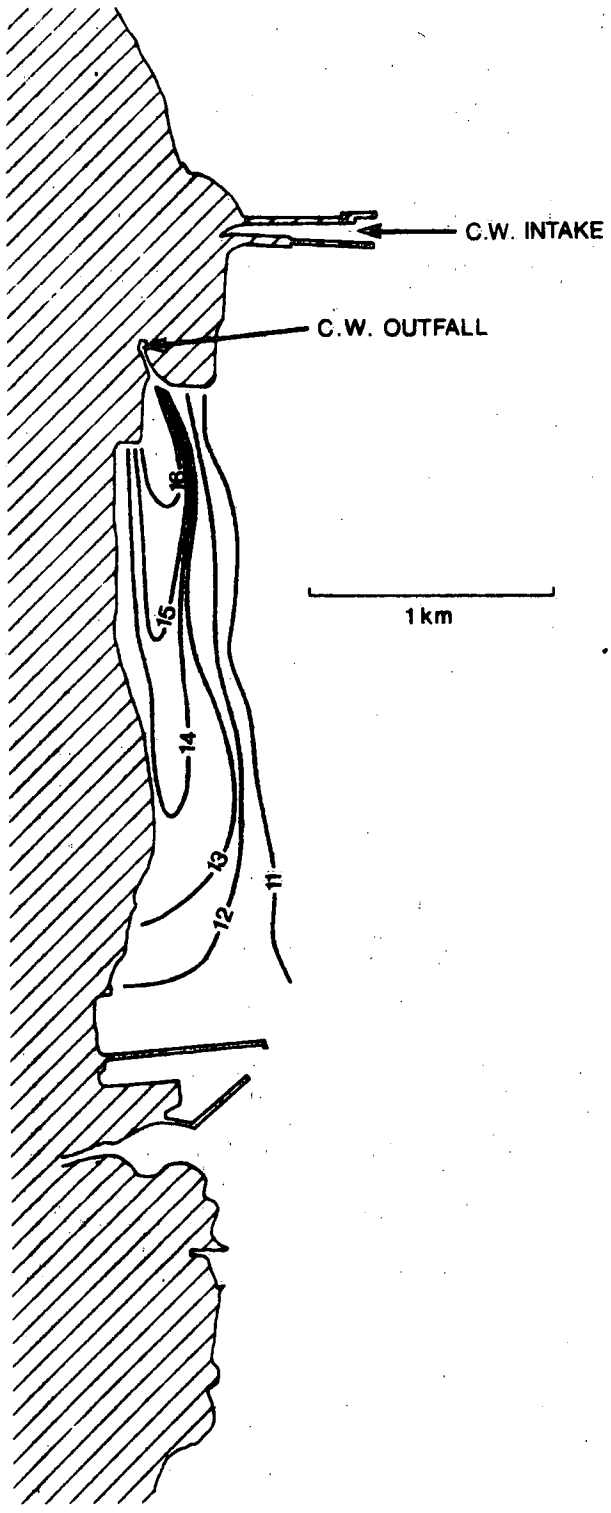


Figure 8. Surface isotherms measured by scanning infrared thermometry. Cooling water effluent (°C). Lakeview thermal generating station, 2200 megawatt capacity. Nov. 9, 1970. Altitude ~ 2000 m.

mented on two occasions by infrared images of the study area obtained by aircraft. A major result of this study was discovery of relatively large zones of cool water where the thermal gradients were weak. These zones (Figure 8) were interpreted as areas of mixing whereby the warm water adjacent to shore was mixed offshore. This study verified that single passes with a ship perpendicular to shore would not necessarily be representative of the thermal conditions in late spring for the area off Oshawa. This is because the position and strength of the maximum thermal gradient parallel to shore could change substantially within one or two kilometres.

Thermal Effluents

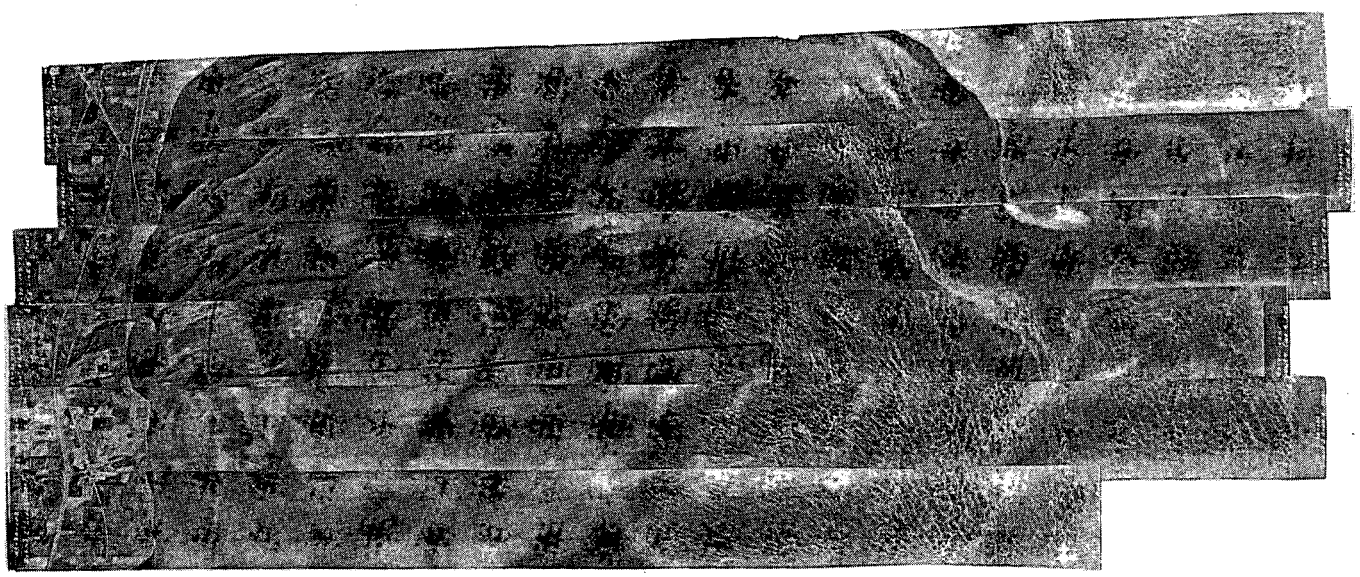
A program is underway to assess the physical effects of the thermal effluent load to the Great Lakes as projected for year 2000 in a study for CCIW by the H.G. Acres Co. An airborne system embodying a scanning infrared radiometer has been developed to facilitate periodic surveys of water surface temperature in the vicinity of several existing thermal effluents (Figure 9). These surveys, which began in September, will continue on a weekly basis into 1971. A strong correlation exists in initial data between the local alongshore component of the wind and thermal plume advection as indicated by surface isotherms. Data on thermal plumes collected by Ontario Hydro has been provided to CCIW for use in this study.

Project "HYPO" – Lake Erie (Diffusion, Currents and Temperatures)

A dye patch diffusion experiment was carried out in early August to study large scale diffusion characteristics of hypolimnetic waters in central Lake Erie (see Chemical Limnology Section report). Experimental data were obtained by fluometric sampling, to define the peak concentration, horizontal and vertical spread of the patch was restricted to the hypolimnion because of the strong thermocline. The horizontal spread was an order of magnitude less, corresponding eddy diffusivity two orders of magnitude less, and the observed peak concentration was two orders of magnitude greater compared to surface layer diffusion ($10^5 cm^2 sec^{-1}$) for comparable time scales of the order of 60 hours.

The currents and temperature data were obtained through co-operation with the U.S. Federal Water Quality Administration in Cleveland who furnished and moored wind recorders, current meters, and thermographs in the central basin of Lake Erie. CCIW is handling the computer processing of the data. While it is known that the volume of hypolimnion water decreases as the stratification proceeds, the exact mechanisms by which the decrease takes place are not clearly understood. The deployment of the moored instruments was designed specifically to study the mecha-

LAKE ONTARIO – OSHAWA AREA



RS 70-102-1 May 14, 1970
Events 2-7 1400 1600 e.d.t.
Grid lines 1-7 Altitude 3000 ft.

Figure 9.

nisms of (1) entrainment of hypolimnion water through the thermocline and (2) mixing of hypolimnion water and epilimnion water around the periphery of the central basin. The 1970 field season was used to deploy the instrumentation and process the data. Analysis will continue into 1971.

Development of Numerical Models

A two part program has been initiated to simulate the water motion in Lake Ontario by numerical models. The first project aims at a systematic investigation and scrutiny of numerical techniques employed in geophysical fluid dynamics and the development of a hierarchy of models describing the circulation of the lake under various conditions. The second project is an extensive verification program to evaluate the accuracy of various models by means of the abundance of observational data on Lake Ontario to become available during 1972 (IFYGL).

The present investigation is concerned with models of the winter circulation of Lake Ontario where the lake is represented by an incompressible homogeneous fluid layer. The primitive system of equations, integrated in the vertical, is used to predict the surface elevation along with the horizontal flow pattern resulting from an imposed wind stress. Included are the effects of the earth's rotation, nonlinear acceleration terms in the equations of motion, lateral boundary configuration, bottom topography, lateral diffusion of momentum, and various types of bottom friction. The effects of each of these terms in the equations are studied in detail before proceeding to more sophisticated models.

The general features of the winter circulation of the lake are found to be in agreement with the steady state results obtained by Rao and Murty of the Marine Sciences Branch, Ottawa. The bottom topography represents the dominant factor in determining the flow pattern. Under the prevailing westerly winds the circulation consists of eastward flow in the shallow northern part of the lake, a very strong and narrow eastward flow along the American shore of the lake, and a westward return flow in the deep central parts of the lake. The jet along the southern shore of the lake has a width of less than 10 km and therefore can just barely be resolved by the finest grid presently used. The strength of the jet depends strongly on the various modelling approximations used in any one model and therefore represents a major subject of study.

Nearshore Current Prediction

Since measurements of nearshore currents do not exist for most of the locations in the Great Lakes, a study was initiated to assess the possibility of predicting them from weather information. Results to date show that the present current component parallel to the shore-line can be predicted with a usable degree of accuracy from winds which occurred about one half day to one and a half days before. The influence of location and distance from shore is

being assessed as a further aid in generalizing the prediction model.

Okanagan Project

The Canada Centre for Inland Waters is participating in the first federal-provincial agreement signed for the purpose of providing scientific information to intelligently manage a major regional water resource. In this case, Canada and British Columbia embarked on a joint program of scientific research in the Okanagan Valley in the interior of British Columbia.

This past year, CCIW has conducted its first of nine monitor cruises in Lakes Okanagan, Osoyoos, Skaha, Woods and Kalamalka. Those cruises are designed to provide base line data on (1) the present nutrient levels in these lakes, (2) the amounts of heat absorbed by these lakes and its manner of distribution, and (3) the ability of the lakes to transmit light down to their deeper portions. All the limnological work was conducted from two seventeen foot outboard boats outfitted with winches, water sampling gear, bathythermographs and instruments designed to measure light transmission through water. Field office and warehouse facilities were set up in Penticton, B.C., which will serve as headquarters for the duration of the study.

Remote Sensing (see also Thermal Plume Studies, above)

In May and July a study was undertaken to investigate the time scale of dominant thermal features on the surface of Lake Ontario. Infrared imagery in the 8-13 micron atmospheric window was taken with a modified Reconofax IV scanner mounted in a light aircraft. The overflights were planned to coincide with the thermal bar study off Oshawa. Hence, ground truth was available from ships in the area. Ground truth was also provided by a Barnes PRT-5 radiometer, in the aircraft. An example of the imagery is shown in Figure 8.

Some investigations into multi-spectral photography continued. Two CF-100 missions were scheduled through the Program Planning Office, Ottawa, in July and October. The July mission coincided with a NASA high altitude photographic experiment on satellite simulation studies, organized through IFYGL co-ordination.

In February of 1970 an investigation unit went to Chedabucto Bay in Nova Scotia to observe the oil spill from the grounded tanker ARROW. Flights were made over the bay with the Reconofax IV infrared scanner, and some multispectral photography was also taken over the polluted areas. Figure 10 shows an example of the oil off the coast as it appears in the spectral range 340 – 480 mm.

Table I contains a summary of remote sensing missions flown for the CCIW program.

Representation from the Physical Limnology Section was included on committees recommending on Canadian plans for remote sensing, including the forthcoming U.S. Earth Resources Technology Satellite series. This particular involvement is through a Water Resources Working Group which reports to the Program Planning Office of the Interdepartmental Committee on Resource Satellites and Remote Airborne Sensing.

Monitor Program – Great Lakes

Preliminary charts of surface distribution of temperature, dissolved oxygen content, conductivity and turbidity were made up after every monitor cruise and distributed to interested persons and agencies. A sample of the charts is contained in Figure 11.

Coastal Temperature Program – Great Lakes

Instrumentation for measuring water temperature at the surface and bottom of the lakes just offshore has been designed by the Engineering Systems Section. Two units have been assembled and installed by the Technical Operations Section and are in operation at Oshawa and Pt. Petre. Five more units are to be built and installed during 1971 at Kingston, Cobourg, Toronto headland, Burlington and Port Weller.

Great Lakes Data Atlas

A Summary Data Atlas which provides information on averages and ranges of certain data, by month, is nearly completed for Lake Ontario. Similar presentations, for others of the Great Lakes, are being developed.

Current Monitoring

In 1970, a current monitoring program was initiated to study the statistical properties of nearshore lake currents in certain select locations in Lake Ontario. Measurements were carried out over the whole year, to assess the current regimes during different seasons. The chosen locations were Kingston, Oshawa, Long Branch near Toronto, Hamilton, and the mouth of the Niagara River. The results, to be published in a technical report, are aimed at providing information useful in the planning of municipal works.

Oil/Water Studies

A program was commenced, at year's end, in the field of oil pollution in lakes. Initial efforts have been spent in acquiring latest information on oil spill containment and cleanup. A modest oil/water research program is anticipated during the following year.

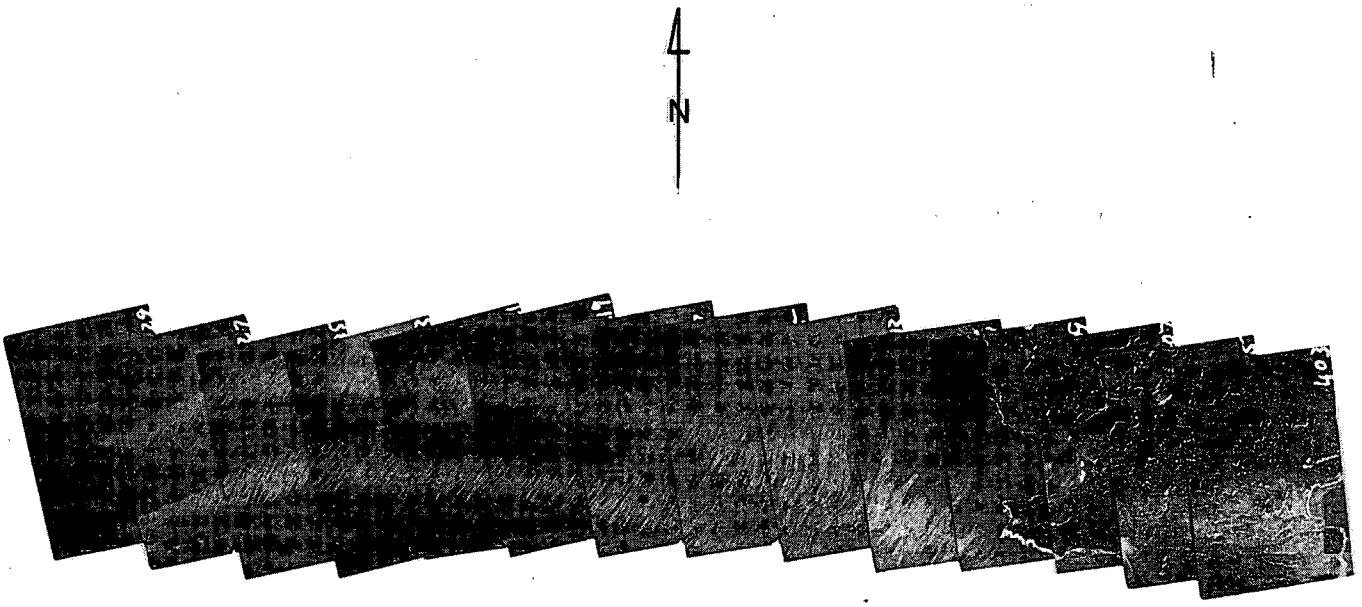


Figure 10. Oil spill in Chedabucto Bay, Nova Scotia, Feb. 1970. Spectral range 340 - 480 mm.

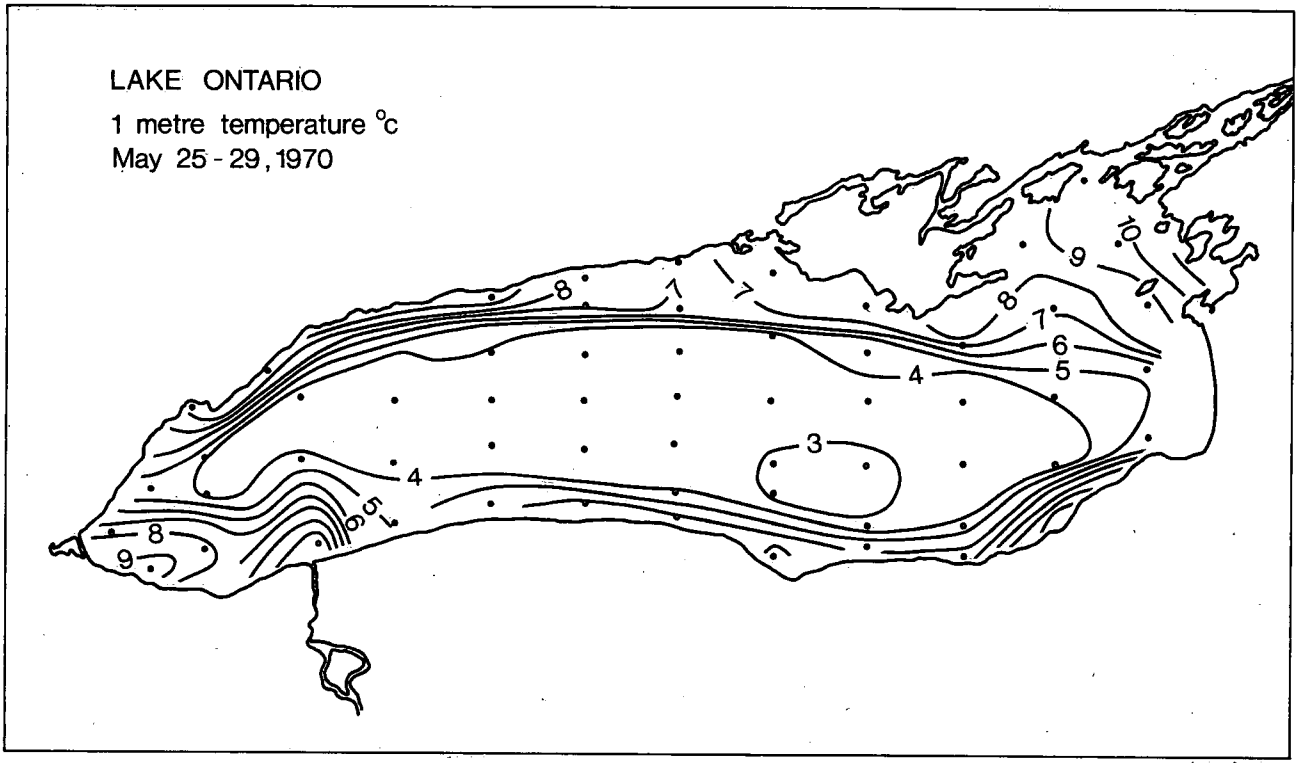


Figure 11.

LIMNOGEOLOGY SECTION

The Limnogeology Section is responsible for undertaking research on the bottom sediments and suspended particulate material in major Canadian lakes and their interconnecting waterways.

Mercury Studies

As part of a series of on-going studies on heavy metals in sediments, a number of sampling programs were under-

TABLE I
C.C.I.W. REMOTE SENSING PROGRAMME 1970

DATE	AIRCRAFT	SENSOR	GROUND TRUTH	LOCATION OR PROJECT
19 OCT	NASA RB 57	MULTI SPECTRAL PHOTOGRAPHY	SHIP DATA	LAKE ONTARIO
10 OCT	CF100	THERMAL SCANNER MULTI SPECTRAL PHOTOGRAPHY	SHIP DATA	LAKE ONTARIO
OCTOBER	PIPER	PRT-5	———	THERMAL PLUME STUDIES LAKEVIEW PLANT
16 JULY	SPARTAN	THERMAL SCANNER	SHIP DATA	OSHAWA
6 JULY	CF100 AND NASA RB57	MULTI SPECTRAL PHOTOGRAPHY	———	LAKE ONTARIO
20 MAY	SPARTAN	THERMAL SCANNER PRT-5	SHIP DATA	OSHAWA
14 MAY	SPARTAN	THERMAL SCANNER PRT-5	SHIP DATA	OSHAWA
14 FEB	NORTH STAR	THERMAL SCANNER MULTISPECTRAL PHOTOGRAPHY	———	CHEDABUCTO BAY NOVA SCOTIA

taken in the following areas: the upper St. Lawrence, between Cornwall and Kingston; the Kingston basin (with special reference to the Charity Shoal, Wolfe Island and Cape Vincent areas); fill-in sampling at scattered locations along the southern shore of Lake Ontario; and Lake St. Clair. Samples taken in 1967, 1968 and 1969, in Lake Huron, Lake Ontario and the Niagara River are also being analyzed. Results show that, at present, input of mercury, into Lake Ontario, comes mainly from the Niagara River. Mercury levels remain relatively high along the south shore of the lake, and possibly receive further enrichment from sources on the United States shore. High mercury levels in sediments from the Wolfe Island – Cape Vincent area were also recorded. Sediments in the Adolphus Reach may also have an increased content of mercury (due to both natural sources and industrial discharge). A core sample from Lake Ontario shows that concentrations of mercury began to exceed background levels in very recent times, probably about 1915. Further, and more dramatic increases occur during the 1939 to 1945 period after which values have continued to rise, though less steeply, up to the present. Mercury levels of more than four times that of the background values have been recorded in sediments of recent years.

Organic Geochemistry

Work has continued on the estimation of sedimentation

Figure 12. Calibrating and setting up the radio navigation system for nearshore studies, using a tellurometer.

rates, using the *Ambrosia* horizon as a marker and datum plane. Most recent estimates for the eastern, central and western basin of Lake Erie give values of 8.2, 4.4 and 0.9 mm/year. In Lake Ontario, a rate of 1.0 mm/year has been estimated for the eastern basin, but mean accumulation rates of up to 1.3 mm/year seem likely.

Studies on the occurrence of chlorophyll in the lake sediments show that Chl_a is usually degraded to pheophytin *a* and pheophorbide *a*; the lack of Chl_b suggests that most of the organic matter is autochthonous.

Humic acids in the surface sediments of Lakes Erie, Huron and Ontario appear to be similar to those found in sub-aerial soils. The humic and fulvic acids closely resemble those of tundra type soils.

Studies on the occurrence of extractable phosphate in the surface sediments of Lakes Ontario and Erie suggest that if, under the worst possible conditions, all of it were to be returned back to the lake water, it would represent only 4 per cent in Lake Ontario and 26 per cent in Lake Erie, of the present-day level of phosphate in the water.

Tests were continued on the suitability of various lake bottom sediments for agricultural usage. The growth of experimental tomato plants indicated that Hamilton Harbour and Lake Ontario muds were superior to the comparison top-grade agricultural soil and that Lake Erie muds were equivalent. Further results, however, suggest that the muds require at least 1 year's cultivation to develop a suitable tilth.

Nearshore and Shoreline Studies

Sediment inventory surveys were continued along the north shore of Lake Ontario and were extended eastwards from Scotch Bonnet Island to Wicked Pt. (Figure 12) As in previous surveys of the north shore of Lake Ontario, the cover of recent sediments over bedrock was found to be extremely thin and bedrock outcrops were exposed at several locations. The only major developments of recent sandy deposits were found in the Dobbs Bank, Willington and Athol Bay areas. A similar survey was commenced in eastern Lake Erie and sampling was completed between Fort Erie and Mohawk Pt. (Figure 13). East of Pt. Colborne, bedrock occurs inshore and medium-fine sand offshore. West of Pt. Colborne bedrock occurs inshore, glacial till and lag deposits at shallow depths and medium-coarse sands in the off-shore areas. Glacio-lacustrine sediments were found at depths of 20 m and more. About 650 km of survey line were run and about 150 sample locations were occupied.

Kingston Basin Area

Several sediment inventory surveys were undertaken in the extreme eastern end of Lake Ontario. These involved about 1500 km of soundings and sampling and coring (Figure 14) at some 340 pre-selected locations. Studies were made on the distribution and type of bottom sediments, their associated fauna, and thickness and type of post-glacial materials.

Pt. Pelee Studies

An intensive study of erosion and sediment movement at Pt. Pelee, Lake Erie, initiated in 1970, was developed in co-operation with the Ontario Department of Lands and Forests. The first phase of this program involved a study of the shoreline and nearshore area from Wheatley, westwards, as far as Willowwood (near the Detroit River). Sampling and soundings were made along 20 traverse lines (perpendicular to the shore), each about 2 km in length. In addition, tracer studies were attempted, south of Pelee Pt., using dyed sand implacements.

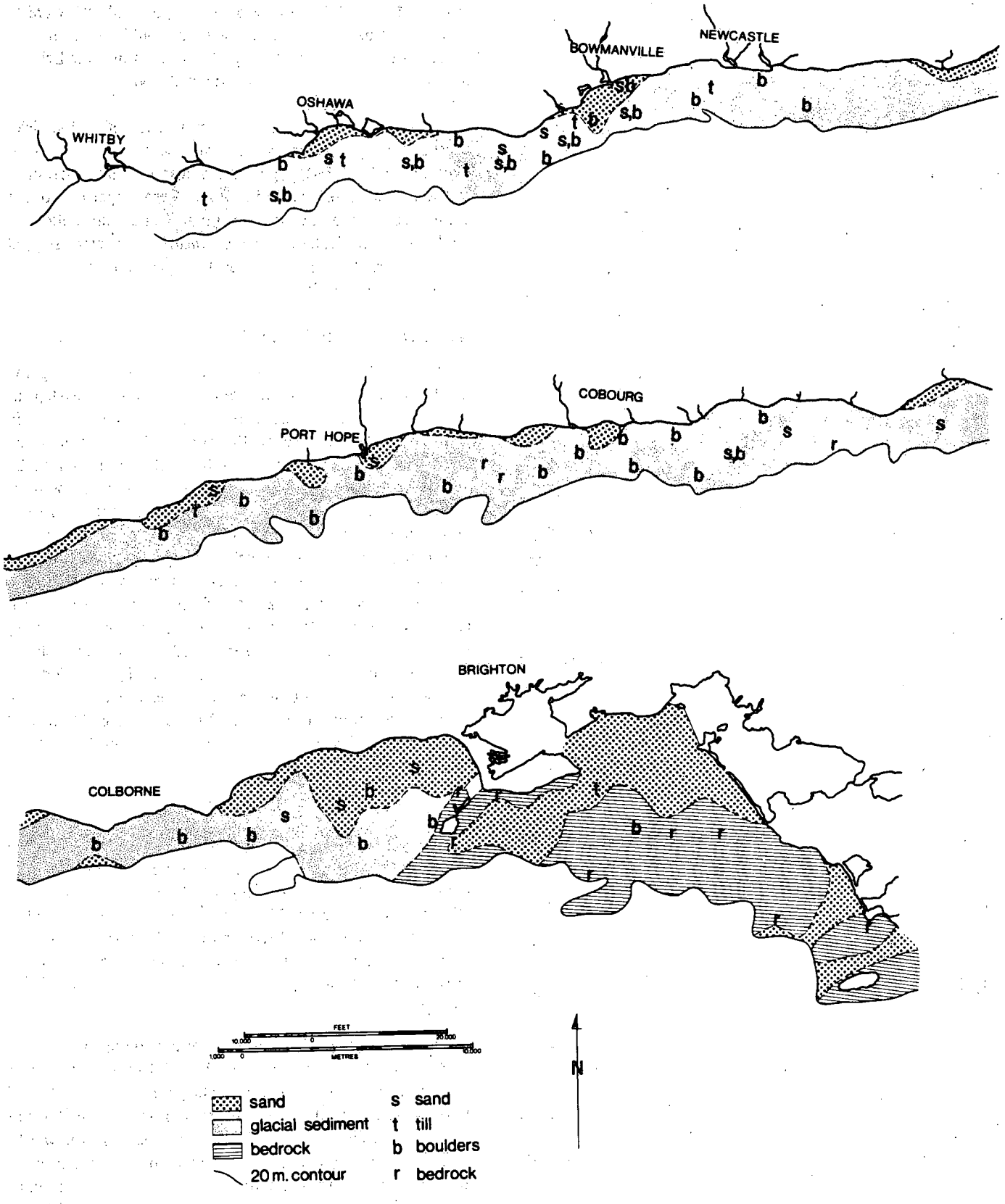

WHITBY
OSHAWA
BOWMANVILLE
NEWCASTLE
PORT HOPE
COBOURG
BRIGHTON
COLBORNE
FEET
METRES
N
sand
glacial sediment
bedrock
20 m. contour
s sand
t till
b boulders
r bedrock

Figure 13.

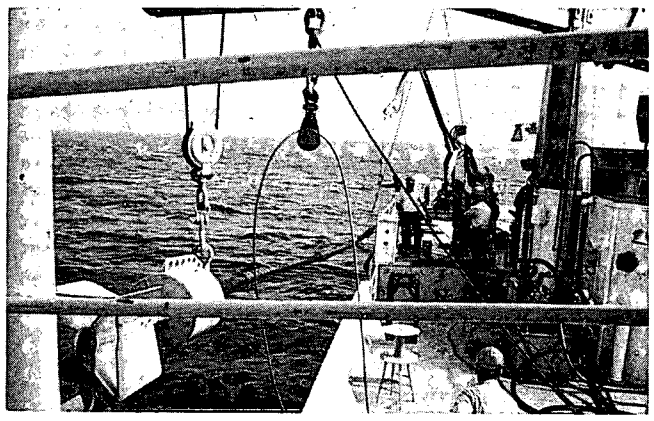


Figure 14. Coring operations, using an Alpine 1200 lb. piston corer, aboard the C.S.S. Limnos, Charity Shoal, Lake Ontario.

Toronto Offshore Study

A continuous seismic reflection survey was completed in the area immediately offshore, between Humber Bay and Highland Creek (Scarborough). Echo sounding and previous sampling programs (covering this area) provided data on the surficial material. Bedrock was found to be at a depth of about 30 m below lake level near the Toronto Islands, and at a depth of 10 to 15 m at the eastern end of the area. Two major buried bedrock valleys were identified. One aligned approximately along the Humber River (at a depth of 15 to 20 m near shore) and traceable to a point about 4 km south of the SE entrance to Toronto Harbour, where it reaches a depth of about 110 to 120 m below lake level. The other valley runs southward from the shoreline at Victoria Park Avenue at a depth of 10 to 15 m and joins with the proto-Humber Valley, SSE of the Toronto Islands, at a depth of about 110 m. This program was undertaken jointly by the Limnogeology Section and the Geological Survey of Canada.

Submersible Operations

In May, 1970, the Canadian Armed Forces Submersible PISCES III (Figure 15) was used for a number of trial dives and operational evaluations in the Tobermory area of Georgian Bay and around Pt. Pelee in Lake Erie. A number of government (federal and provincial) departments were involved, together with universities and industry. The University of Michigan (Ann Arbor) also participated. Observations and interpretations of bedrock outcrops, sediment type and environmental conditions were successfully made at a number of locations. Weather conditions were, however, far from ideal and the support craft (35 m barge with deck-mounted crane and a 20 m tug) were restricted to sheltered locations for launch and recovery of the submersible. The potential of submersibles for some specially selected research programs appears high.

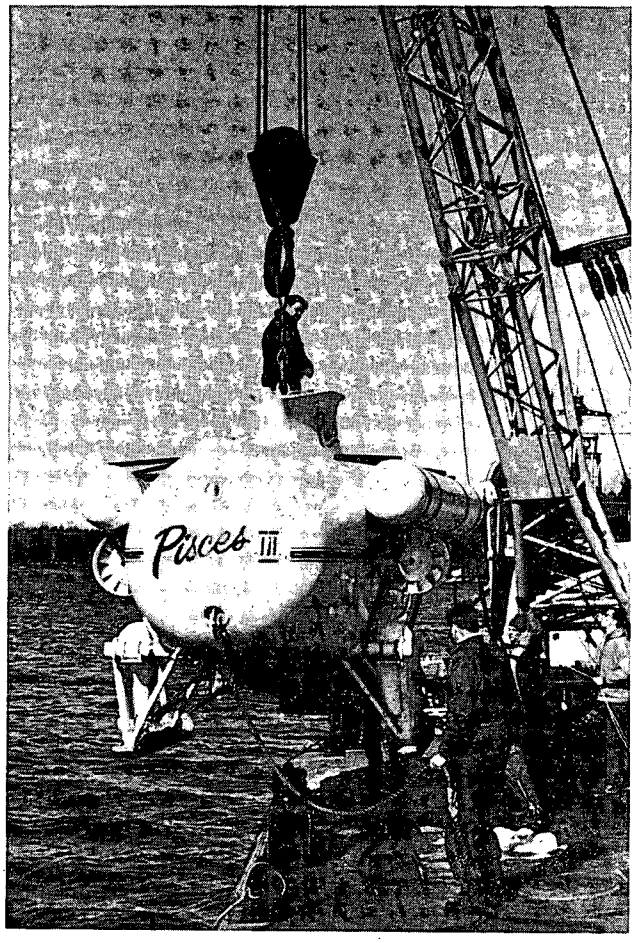


Figure 15. The submersible PISCES III being launched from the barge HANDY BOY, Georgian Bay, May 1970.

Equipment

A number of items of equipment were designed and built to meet requirements, (see also report of Engineering Systems Section). A triple corer with precision extruder was developed for geochemical sampling, and can be used from all but the smallest of launches. A portable coring winch and tripod was designed specifically for through-ice sampling on frozen lakes. It is operational in temperatures down to -40°C; it can lift 400 kg (under gasoline power) and can "break-out" a load in excess of 1,000 kg (under manual power). The whole assembly is trailerable by snowmobile and can be flown into remote locations by light aircraft. A vibro-corer system using a pneumatic source, was developed for coring sandy sediments; radiographs have shown minimum sediment disturbance. Modifications to the continuous seismic reflection profiling equipment were completed. The recorder, which is

compatible with either boomer or air-gun sources, has been coupled with a magnetic recorder which tapes unfiltered signals that can be replayed with any filter combinations for future analysis. A new boomer source should provide excellent discrimination of shallow reflectors. Development has continued with an UW time-lapse photographic system to record sediment movement in the nearshore zone. Trials, in Georgian Bay, appeared very promising. Tests with a suspended-load pumping and continuous centrifuging system in the east end of Lake Ontario showed that more than 80 per cent of the material recovered (above 0.01μ) was organic. Construction has been started on a new sedimentology trailer for use as a field laboratory and designs for a new, trailerable, shallow-water coring platform are currently under study.

Contracts

The Geology Department of Lakehead University continued a geological survey of the nearshore and shoreline areas of the Canadian shoreline of Lake Superior, under contract to CCIW. Studies of the Thunder Bay and Black Bay areas were completed.

Barringer Research, Toronto, provided analytical services to the inorganic geochemistry unit of the Section, specifically for the identification of mercury by means of an interference-free mercury spectrometer. Several hundred analyses have been completed.

TECHNICAL OPERATIONS SECTION

Major Ships

The Section continued to use the two major vessels, C.S.S. LIMNOS and the charter vessel M.V. MARTIN KARLSEN, as in the previous year, for scientific data collection and monitoring work. The monitoring of the upper lakes was augmented from time to time by the C.G.G.S. PORTE DAUPHINE, Ministry of Transport through contract arrangements with Great Lakes Institute, University of Toronto.

C.S.S. LIMNOS carried out many varied cruises using a variety of scientific equipment. Included in these operations was project "HYPO" (the Hypolimnion Project, Lake Erie) and a series of instrument development cruises which were coincident with remote sensing overflights on Lake Ontario. The mechanical problems which had plagued the ship in 1969 were seemingly ironed out, resulting in better performance and little down time.

M.V. MARTIN KARLSEN continued to be the workhorse of the fleet in monitor work, being in continuous operation throughout the year and completing four cruises on Lake Ontario during the winter months which was a new departure for CCIW operations.

C.C.G.S. PORTE DAUPHINE was under contract when our major ships were unavailable for monitor cruises on the upper Great Lakes. These cruises, staffed by the Great Lakes Institute, were co-ordinated by Technical Operations and complemented our regular monitor program in these areas.

Minor Ships

C.S.S. RADEL II was based at CCIW, on call for coastal spills and engineering development, scientific tower erection and thermal surveys. This vessel also undertook CCIW's first pesticide study for the Environmental Quality Co-ordination Unit in Lakes Ontario and Erie which incorporated new trawling techniques for CCIW in ground fishing.

The chartered tug M.V. LAC ERIE was used mainly on Mini-Fix surveys for the Limnogeology Section, sampling sediments in the Kingston Basin area. Earlier in the summer she assisted during submersible operations at Tobermory and Lake Erie.

Small Craft

The Technical Operations Section continued to co-ordinate, through Central Region, Marine Sciences Branch, the assignment of the fleet of small craft to various Sections

OPERATIONAL TABLE 1970

Ship	Commenced Operations	Completed Operations	Miles Steamed	Total Active Days	Days on Survey	Percent
C.S.S. LIMNOS	March 16	December 14	15,741	272	171	62.5
M.V. MARTIN KARLSEN	January 6	December 19	28,373	291	224	76.4

(complete schedules are given in Tables II and III)

at CCIW, universities and outside agencies.

Personnel

Personnel from the Section were assigned to major and minor ships on a continuing basis throughout the season, and to small craft involved with shore-based scientific survey parties. These surveys were based at Oshawa, Erieau, Kingston and the Okanagan.

The staff were responsible for all deck observations, field equipment and co-ordination of vessel movements. Routine meteorological observations and reports were also carried out by this group and transmitted regularly to Meteorological Branch forecast centres. Both major ships were given a Group Award for excellence in marine weather reporting for this function.

Eight student assistants were employed by the Section during the summer season on field operations.

Okanagan Basin Project

Two Operations personnel co-ordinated and carried out the main sampling program in the Okanagan Basin Pilot Study. This was a fall operation, carried out specifically to evaluate problems which could conceivably occur during the 1971, eight month Okanagan area field survey. The work also provided a great deal of important and heretofore unknown limnological data about the lakes in the basin.

Submersible Operation

The submersible PISCES III was used in the Georgian Bay/Tobermory area in early May. Two Operations personnel co-ordinated activities of the various agencies concerned with diving in the craft, and with the movement and control of equipment, which consisted of auxiliary craft, the tug LAC ERIE, barge HANDY-BOY and a Jet Ranger helicopter. The craft itself was operated by Canadian Armed Forces personnel.

The depths in which the vehicle was used ranged from 30 feet in Big Tub Harbour, to 250 feet in Georgian Bay. This program was continued in Lake Erie from Kingsville to Erieau in late May, before return of the submersible to the Canadian Armed Forces on the East Coast.

Diving Section

A Senior Diving Officer was taken on strength in early spring. His main duties have been direction of all diving at CCIW, and the supervision of all outside diving contracts. In addition, a "Diving Policy" and Manual has been drafted which is a policy directive setting forth requirements to be adhered to by all persons who will be diving as part of their duties with CCIW.

The Senior Diving Officer, together with contract divers and Technical Operations personnel, erected towers in lake locations at Kenora and Hamilton Beach for measurement of water conditions and related meteorological factors. Many other underwater studies and techniques have also been undertaken and assistance was given to the Central Region, MSB fleet from time to time.

Miscellaneous

Technical Operations staff co-operated on several occasions with the Environmental Quality Co-ordination Unit in investigating reports of oil spills and leakages. It is anticipated that these emergencies will continue to be met in an increased amount by this Section with the naming of CCIW as the Regional Co-ordination Centre for the federal contingency plan on the Great Lakes.

During the year a new measure was instituted whereby scientific observers accompanied Technical Operations staff on monitor cruises to observe and suggest modifications of sampling techniques and other operations.

Personnel from several agencies, such as CODC and Data Quality Control Unit, who prepare data from cruise reports for reports, took part in several monitor cruises as part of a training program whereby their personnel were given a first hand look at how the field data are being collected, measured and analyzed.

A new experimental "floating" tower was successfully tested off Hamilton Beach during the summer survey season. This tower, developed by Technical Operations, and known as a Self Mooring Platform (S.M.P.) was towed floating to a pre-arranged position and sunk by opening the sea-cocks. The S.M.P. was used for housing meteorological instruments from spring until late fall by the Physical Limnology Section, who reported that the tower was very stable and the test most successful. Compressed air was blown into the ball-shaped cylinders to re-float the tower and it was towed back to CCIW in late fall.

INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES (IFYGL) CENTRE

CCIW continued to provide staff and facilities for the IFYGL (Canadian Co-ordinator's Office). The IFYGL is a comprehensive synoptic study of the Lake Ontario Basin, with five major scientific sub-programs to investigate the details of the physical limnology, the basin meteorology, the lake energy budget and radiation climate, the terrestrial water budget and hydrology of the basin, and the biology and chemistry of the lake. Planning discussions have continued since 1965, but commitments to the program have only recently been made in Canada and the United

GREAT LAKES STUDIES – 1970 – CSS LIMNOS

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JANUARY	4	5	6	7	8	9	10
	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31
FEBRUARY	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	27	28
MARCH	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16 Depart CCIW 1000 hrs	17 Benthos Coring Lake Ontario	18 Benthos Coring Lake Ontario	19 Benthos Coring Lake Ontario	20 Arrive CCIW 0840 hrs.	21 CCIW
	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW
	29 CCIW	30 CCIW	31 CCIW	1 Depart CCIW 1000 hrs. In transit	2 Mooring Cruise Lake Erie	3 Mooring Cruise Lake Erie	4 Mooring Cruise Lake Erie
APRIL	5 Arrived Sarnia 1740 hrs	6 Sarnia	7 Sarnia	8 Sarnia	9 Depart Sarnia 1100 hrs	10 Mooring Cruise Lake Huron	11 Mooring Cruise Lake Huron
	12 Mooring Cruise Lake Huron	13 Mooring Cruise Lake Huron	14 Mooring Cruise Lake Huron	15 Mooring Cruise Lake Huron	16 Arrived CCIW 0200 hrs	17 Depart CCIW 1000 hrs	18 Mooring Cruise Lake Ontario
	19 Mooring Cruise Lake Ontario	20 Arrive CCIW 1410 hrs	21 CCIW	22 CCIW	23 CCIW	24 Departed for Dry Dock	25 Dry Dock
	26 Dry Dock	27 Dry Dock	28 Dry Dock	29 Dry Dock	30 Dry Dock	1 Dry Dock	2 Dry Dock
MAY	3 Dry Dock	4 Dry Dock	5 Dry Dock	6 Dry Dock	7 Dry Dock	8 Dry Dock	9 Dry Dock
	10 Dry Dock	11 Dry Dock	12 Dry Dock	13 Dry Dock	14 Arrived from Dry Dock	15 Depart CCIW 0100 hrs	16 Time Series Lake Ontario
	17 Time Series Lake Ontario	18 Time Series Lake Ontario	19 Time Series Lake Ontario	20 Time Series Lake Ontario	21 Time Series Lake Ontario	22 Arrived CCIW 1250 hrs	23 CCIW
	24 CCIW	25 Depart CCIW 1155 hrs	26 Time Series Lake Ontario	27 Time Series Lake Ontario	28 Time Series Lake Ontario	29 Time Series Lake Ontario	30 Arrived CCIW 0850 hrs
JUNE	31 CCIW	1 Depart 1040 hrs Time Series Ont.	2 Arrived CCIW 2235 hrs	3 CCIW	4 CCIW	5 CCIW	6 CCIW
	7 CCIW	8 CCIW	9 Depart CCIW 1620 hrs	10 Moorings & Echo Sounding L. Ont.	11 Moorings & Echo Sounding L. Ont.	12 Arrived CCIW 1840 hrs	13 CCIW
	14 CCIW	15 Depart CCIW 1200 hrs	16 Horz. Turbulence Meas. W. L. Ont.	17 Horz. Turbulence Meas. W. L. Ont.	18 Arrived CCIW 1830 hrs	19 CCIW	20 CCIW
	21 CCIW	22 Depart CCIW 1000 hrs	23 Mooring Cruise Lake Ontario	24 Mooring Cruise Lake Ontario	25 Arrived CCIW 1825 hrs	26 CCIW	27 CCIW
	28 CCIW	29 CCIW	30 CCIW	1 CCIW	2 Depart CCIW 1000 hrs	3 Inst. Development Lake Ontario	4 Inst. Develop. Lake Ontario
JULY	5 Inst. Develop. Lake Ontario	6 Inst. Develop. Lake Ontario	7 Inst. Develop. Lake Ontario	8 Inst. Develop. Lake Ontario	9 Inst. Develop. Lake Ontario	10 Arrived CCIW 1450 hrs	11 CCIW
	12 CCIW	13 Depart CCIW 1020 hrs	14 Inst. Develop. Lake Ontario	15 Inst. Develop. Lake Ontario	16 Inst. Develop. Lake Ontario	17 Inst. Develop. Lake Ontario	18 Arrived CCIW 1905 hrs
	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 OECD Cruise	24 CCIW	25 CCIW
	26 Depart CCIW 1953 hrs Canal Trans.	27 Project HYPO Lake Erie	28 Project HYPO Lake Erie	29 Project HYPO Lake Erie	30 Project HYPO Lake Erie	31 Project HYPO Lake Erie	1 Project HYPO Lake Erie
AUGUST	2 Project HYPO Lake Erie	3 Project HYPO Lake Erie	4 Project HYPO Lake Erie	5 Project HYPO Lake Erie	6 Project HYPO Lake Erie	7 Project HYPO Lake Erie	8 Project HYPO Lake Erie
	9 Project HYPO Lake Erie	10 Project HYPO Lake Erie	11 Project HYPO Lake Erie	12 Project HYPO Lake Erie	13 Project HYPO Lake Erie	14 Project HYPO Lake Erie	15 Project HYPO Lake Erie
	16 Project HYPO Lake Erie	17 Project HYPO Lake Erie	18 Project HYPO Lake Erie	19 Project HYPO Lake Erie	20 Project HYPO Lake Erie	21 Project HYPO Lake Erie	22 Project HYPO Lake Erie
	23 Project HYPO Lake Erie	24 Project HYPO Lake Erie	25 Project HYPO Lake Erie	26 Arrived CCIW 2145 hrs	27 CCIW	28 CCIW	29 CCIW
SEPTEMBER	30 CCIW	31 Depart CCIW 1200 hrs	1 Mooring Cruise Lake Ontario	2 Mooring Cruise Lake Ontario	3 Arrived CCIW 1440 hrs	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 Depart CCIW 0852 Canal Transit	9 Mooring Cruise Lake Huron	10 Mooring Cruise Lake Huron	11 Mooring Cruise Lake Huron	12 Mooring Cruise Lake Huron
	13 Mooring Cruise Lake Huron	14 Mooring Cruise Lake Huron	15 Mooring Cruise Lake Huron	16 Mooring Cruise Lake Huron	17 Mooring Cruise Lake Huron	18 Arrived CCIW 1930 hrs	19 CCIW
	20 CCIW	21 Depart CCIW 1040 hrs	22 Coring & Echo Sounding L. Ont.	23 Coring & Echo Sounding L. Ont.	24 Coring & Echo Sounding L. Ont.	25 Arrived CCIW 0640 hrs	26 CCIW
	27 CCIW	28 CCIW	29 Depart CCIW 0043 hrs	30 Inst. Develop. Lake Ontario	1 Inst. Develop. Lake Ontario	2 Inst. Develop. Lake Ontario	3 Inst. Develop. Lake Ontario
OCTOBER	4 Inst. Develop. Lake Ontario	5 Inst. Develop. Lake Ontario	6 Inst. Develop. Lake Ontario	7 Inst. Develop. Lake Ontario	8 Inst. Develop. Lake Ontario	9 Arrived CCIW 0500 hrs	10 CCIW
	11 CCIW	12 CCIW	13 Depart CCIW 0925 Canal Transit	14 Mooring Cruise Lake Erie	15 Mooring Cruise Lake Erie	16 Arrive CCIW 0415 hrs	17 CCIW
	18 CCIW	19 Depart CCIW 1015 Inst. Develop.	20 Arrive CCIW 1905 Lake Ontario	21 Depart CCIW 2356 hrs	22 Coring & Special Lake Ontario	23 Coring & Special Lake Ontario	24 Coring & Special Lake Ontario
	25 Arrive CCIW 0650 hrs	26 CCIW	27 Depart CCIW 0840 hrs	28 Mooring Lake Ontario	29 Mooring Lake Ontario	30 Mooring Lake Ontario	31 Mooring Lake Ontario
NOVEMBER	1 Mooring Lake Ontario	2 Mooring Lake Ontario	3 Mooring Lake Ontario	4 Mooring Lake Ontario	5 Mooring Lake Ontario	6 Arrive CCIW 1449 hrs	7 CCIW
	8 CCIW	9 CCIW	10 CCIW	11 Port Weller Dry Dock	12 Port Weller Dry Dock	13 Arrived CCIW 1545 hrs	14 CCIW
	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 0835 hrs	25 Mooring Lake Huron	26 Mooring Lake Huron	27 Mooring Lake Huron	28 Mooring Lake Huron
	29 Mooring Lake Huron	30 Arrive Windsor 1240 hrs	1 Depart Windsor 0613 hrs	2 Mooring Lake Erie	3 Mooring Lake Erie	4 Arrive CCIW 0210 hrs	5 CCIW
DECEMBER	6 CCIW	7 Depart CCIW 1000 hrs	8 Mooring Lake Ontario	9 Mooring Lake Ontario	10 Mooring Lake Ontario	11 Mooring Lake Ontario	12 Mooring Lake Ontario
	13 Mooring Lake Ontario	14 Arrive CCIW 1500 hrs	15 END	16 OF	17 FIELD	18 SEASON	19

GREAT LAKES STUDIES – 1970 – MV. MARTIN KARLSEN

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
JANUARY	4 CCIW	5 CCIW	6 Depart CCIW 1515 hrs	7 Monitor Lake Ontario	8 Monitor Lake Ontario	9 Monitor Lake Ontario	10 Monitor Lake Ontario
	11 Monitor Lake Ontario	12 Arrive CCIW 0955 hrs	13 CCIW	14 CCIW	15 CCIW	16 CCIW	17 CCIW
	18 CCIW	19 CCIW	20 CCIW	21 CCIW	22 CCIW	23 CCIW	24 CCIW
	25 CCIW	26 CCIW	27 CCIW	28 CCIW	29 CCIW	30 CCIW	31 CCIW
FEBRUARY	1 CCIW	2 CCIW	3 Depart CCIW 1542 hrs	4 Monitor Lake Ontario	5 Monitor Lake Ontario	6 Monitor Lake Ontario	7 Monitor Lake Ontario
	8 Monitor Lake Ontario	9 Arrive CCIW 0940 hrs	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 CCIW	24 CCIW	25 CCIW	26 CCIW	27 CCIW	28 CCIW
MARCH	1 CCIW	2 CCIW	3 Depart CCIW 1400 hrs	4 Monitor Lake Ontario	5 Monitor Lake Ontario	6 Monitor Lake Ontario	7 Monitor Lake Ontario
	8 Monitor Lake Ontario	9 Arrive CCIW 0900 hrs	10 CCIW	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 CCIW	17 CCIW	18 CCIW	19 CCIW	20 CCIW	21 CCIW
	22 CCIW	23 Depart CCIW 1050 hrs	24 Mooring Lake Ontario	25 Mooring Lake Ontario	26 Arrive CCIW 1145 hrs	27 CCIW	28 CCIW
	29 CCIW	30 CCIW	31 Depart CCIW 1505 hrs	1 Monitor Lake Ontario	2 Monitor Lake Ontario	3 Monitor Lake Ontario	4 Monitor Lake Ontario
APRIL	5 Arrive CCIW 1240 hrs	6 Depart CCIW 1535 hrs	7 Monitor Lake Erie	8 Monitor Lake Erie	9 Monitor Lake Erie	10 Monitor Lake Erie	11 Arrive Sarnia 1633 hrs
	12 Sarnia	13 Depart Sarnia 1645 hrs	14 In Transit	15 Monitor Lake Superior	16 Monitor Lake Superior	17 Monitor Lake Superior	18 Monitor Lake Superior
	19 Monitor Lake Superior	20 Monitor Lake Superior	21 Monitor Lake Superior	22 Monitor Lake Superior	23 Monitor Lake Superior	24 Transit	25 Arrive CCIW 1910 hrs
	26 CCIW	27 CCIW	28 Depart CCIW 1000 hrs	29 Monitor Lake Ontario	30 Monitor Lake Ontario	1 Monitor Lake Ontario	2 Arrive CCIW 1600 hrs
MAY	3 CCIW	4 CCIW	5 Depart CCIW 1100 hrs	6 Monitor Lake Erie	7 Monitor Lake Erie	8 Monitor Lake Erie	9 Monitor Lake Erie
	10 Arrive Sarnia 2100 hrs	11 Depart Sarnia 1800 hrs	12 Monitor Lake Huron	13 Monitor Lake Huron	14 Monitor Lake Huron	15 Monitor Lake Huron	16 Monitor Lake Huron
	17 Monitor Lake Huron	18 Monitor Lake Huron	19 In Transit	20 In Transit	21 Arrive CCIW 0300 hrs	22 CCIW	23 CCIW
	24 CCIW	25 Depart CCIW 0950 hrs	26 Monitor Lake Ontario	27 Monitor Lake Ontario	28 Monitor Lake Ontario	29 Arrive CCIW 1810 hrs	30 CCIW
JUNE	31 CCIW	1 Depart CCIW 1315 hrs	2 Monitor Lake Erie	3 Monitor Lake Erie	4 Monitor Lake Erie	5 Monitor Lake Erie	6 Arrive Sarnia 1615 hrs
	7 Sarnia	8 Depart Sarnia 1915 hrs	9 Mooring Lake Huron	10 Mooring Lake Huron	11 Mooring Lake Huron	12 Sarnia Arrive 1225 Dep. 1410	13 Mooring Lake Erie
	14 Mooring Lake Erie	15 Arrive Port Weller 2105 hrs	16 Dry Dock	17 Dry Dock	18 Dry Dock	19 Dry Dock	20 Dry Dock
	21 Dry Dock	22 Arrive CCIW 0700 Dep. 1620	23 Monitor Lake Ontario	24 Monitor Lake Ontario	25 Monitor Lake Ontario	26 Monitor Lake Ontario	27 Monitor Lake Ontario
	28 Arrive CCIW 1300 hrs	29 CCIW	30 CCIW	1 CCIW	2 Depart CCIW 1035 hrs	3 Monitor Lake Erie	4 Monitor Lake Erie
JULY	5 Monitor Lake Erie	6 Monitor Lake Erie	7 Monitor Lake Erie	8 Arrive CCIW 1830 hrs	9 Depart CCIW 1300 hrs	10 Dry Dock	11 Dry Dock
	12 Arrive CCIW 1000 hrs	13 CCIW	14 CCIW	15 CCIW	16 Depart CCIW 1040 hrs	17 Monitor Lake Ontario	18 Monitor Lake Ontario
	19 Monitor Lake Ontario	20 Monitor Lake Ontario	21 Arrive CCIW 0815 hrs	22 CCIW	23 OECD Cruise	24 CCIW	25 CCIW
	26 CCIW	27 Depart CCIW 0930 hrs	28 Monitor Lake Erie	29 Monitor Lake Erie	30 Monitor Lake Erie	31 Monitor Lake Erie	1 Monitor Lake Erie
AUGUST	2 Arrive CCIW 0800 hrs	3 CCIW	4 CCIW	5 Depart CCIW 0840 hrs	6 Instrument Development	7 Arrive CCIW 1600 hrs	8 CCIW
	9 CCIW	10 Depart CCIW 0930 hrs	11 Internal Waves Lake Ontario	12 Internal Waves Lake Ontario	13 Internal Waves Lake Ontario	14 Arrive CCIW 1315 hrs	15 CCIW
	16 CCIW	17 Depart CCIW 0920 hrs	18 Monitor Lake Ontario	19 Monitor Lake Ontario	20 Monitor Lake Ontario	21 Arrive CCIW 2115 hrs	22 CCIW
	23 CCIW	24 Depart CCIW 1330 hrs	25 Monitor Lake Erie	26 Monitor Lake Erie	27 Monitor Lake Erie	28 Monitor Lake Erie	29 Monitor Lake Erie
SEPTEMBER	30 Arrive CCIW 1130 hrs	31 CCIW	1 CCIW	2 CCIW	3 CCIW	4 CCIW	5 CCIW
	6 CCIW	7 CCIW	8 Depart CCIW 1130 hrs	9 Dry Dock	10 Depart Dry Dock 0230 hrs	11 Mooring Lake Erie	12 Arrive CCIW 2300 hrs
	13 CCIW	14 Depart CCIW 1250 hrs	15 Monitor Lake Ontario	16 Monitor Lake Ontario	17 Monitor Lake Ontario	18 Monitor Lake Ontario	19 Arrive CCIW 2010 hrs
	20 CCIW	21 CCIW	22 Depart CCIW 1200 hrs	23 Monitor Lake Erie	24 Monitor Lake Erie	25 Monitor Lake Erie	26 Monitor Lake Erie
	27 Arrive Sarnia 2230 hrs	28 Sarnia	29 Depart Sarnia 0800 hrs	30 Monitor Lake Huron	1 Monitor Lake Huron	2 Monitor Lake Huron	3 Monitor Lake Huron
OCTOBER	4 Monitor Lake Huron	5 Monitor Lake Huron	6 Monitor Lake Huron	7 In Transit	8 In Transit	9 Arrive CCIW 1725 hrs	10 CCIW
	11 CCIW	12 CCIW	13 Depart CCIW 1210 hrs	14 Monitor Lake Ontario	15 Monitor Lake Ontario	16 Monitor Lake Ontario	17 Arrive CCIW 1945 hrs
	18 CCIW	19 CCIW	20 Depart CCIW 1020 hrs	21 Monitor Lake Erie	22 Monitor Lake Erie	23 Monitor Lake Erie	24 Monitor Lake Erie
	25 Monitor Lake Erie	26 Arrive Sarnia 0950 Dep. 1745	27 Monitor Lake Superior	28 Monitor Lake Superior	29 Monitor Lake Superior	30 Monitor Lake Superior	31 Monitor Lake Superior
NOVEMBER	1 Monitor Lake Superior	2 Monitor Lake Superior	3 Monitor Lake Superior	4 Monitor Lake Superior	5 Monitor Lake Superior	6 Monitor Lake Superior	7 Monitor Lake Superior
	8 Monitor Lake Superior	9 Monitor Lake Superior	10 Arrive CCIW 1205 hrs	11 CCIW	12 CCIW	13 CCIW	14 CCIW
	15 CCIW	16 Depart CCIW 0925 hrs	17 Monitor Lake Ontario	18 Monitor Lake Ontario	19 Monitor Lake Ontario	20 Arrive CCIW 1745 hrs	21 CCIW
	22 CCIW	23 CCIW	24 Depart CCIW 0855 hrs	25 Monitor Lake Erie	26 Monitor Lake Erie	27 Monitor Lake Erie	28 Monitor Lake Erie
	29 Monitor Lake Erie	30 Monitor Lake Erie	1 Arrive CCIW 1340 hrs	2 CCIW	3 CCIW	4 CCIW	5 CCIW
DECEMBER	6 CCIW	7 Depart CCIW 2030 hrs	8 Monitor Lake Ontario	9 Monitor Lake Ontario	10 Monitor Lake Ontario	11 Monitor Lake Ontario	12 Arrive CCIW 0800 hrs
	13 Depart CCIW 1200 hrs	14 Monitor Lake Erie	15 Monitor Lake Erie	16 Monitor Lake Erie	17 Monitor Lake Erie	18 Monitor Lake Erie	19 Arrive CCIW 1200 hrs

States. The schedule is to conduct one calendar year of intensive data gathering from January 1 to December 31, 1972, preceded by instrument and technique inter-comparison and trials during 1971. Data analysis, reduction and publication of results will continue through to 1974.

The primary objective of the IFYGL is to provide, through co-operation between Canada and U.S.A., a set of comprehensive "synoptic" data on one of the Great Lakes basins which will lead to a much better understanding of the lake system and to improved management of Lake Ontario, in particular, and other large lakes. It will also develop improved methods of assessing the interaction between the atmosphere and large water bodies of the world.

For some time now it has been clear that it was necessary to move from the program planning phase of the Field Year towards implementation. A Workshop held on 31 August – 2 September 1970 at McMaster University, Hamilton, punctuated this necessary move forward and gave all recently involved investigators a chance to meet and discuss matters with colleagues from both sides of the border. Presentations of the planned scientific program were also made this year at the 13th Conference for Great Lakes Research (Bolsenga, MacDowall) Buffalo, N.Y. and at the World Water Balance Conference in Reading, England (MacDowall). The objectives and program are summarized in the September 1970 issue of the Bulletin of the International Association for Scientific Hydrology (p 125-127).

During this past field season the CCIW and the Canadian Meteorological Service have worked together on the development of the deep-water meteorological buoy system for lakewide use during the IFYGL. The CCIW designed and constructed the system and then compared the performance of the meteorological observation part of the system with Canadian Meteorological Service equipment, at the CMS experimental farm near Woodbridge. The results were satisfactory to the investigators planning to use the Field Year data.

Other Field Year feasibility studies and trials undertaken by the CCIW in this season were as follows: coastal chain and diffusion studies off Oshawa (in collaboration with University of Waterloo), trials and evaluation of a towed thermistor device of the Bedford Institute, the "Batfish" thermal profiler; remote sensing using infrared scanning and photographic techniques in association with the United States National Aeronautics and Space Administration and the Geological Survey; and a theoretical analysis of the instrumentation problems and accuracy requirements of various methods of directly measuring atmospheric fluxes over the lake. Successful overflights of the western end of Lake Ontario were co-ordinated with ground work by the IFYGL Centre at CCIW on 6 July and 19 October, 1970.

The feasibility study by the Canadian Meteorological Service has continued, on the atmospheric water budget experiment, which envisages use of six radiosonde stations around the lake to measure the difference between up- and down-wind flows of water vapour across the lake. United States scientists were invited to participate, and brought their own equipment, in a three-station trial held along the shoreline of Lake Ontario from Scarborough to Burlington. This third feasibility study of the technique was conducted from 7 -18 December 1970 and used about 50 radiosonde flights to observe the horizontal variability of atmospheric winds and water vapour content. Accommodation for the U.S. scientists was provided at CCIW.

An experiment to examine the feasibility of observing lake surface temperatures from the presently orbiting ESSA satellites was conducted. Ground truth for this work was acquired by airborne radiation thermometry by the Canadian Meteorological Service. The results encourage the view that at some time in the future Lake Ontario surface temperatures may be obtained from satellites with useful accuracy and resolution, but the presently orbiting equipment is not yet suitable.

Proper management of the Great Lakes can only be based on an understanding of many interrelated processes whose seasonal changes result in the time and space variations of chemical, biological and physical factors. In order to achieve its objective, a core program in biology and chemistry was adopted at the Steering Committee meeting on 14 October 1970. This program is based on the following elements: lake-wide systematic biological observations of phytoplankton, zooplankton, fish and benthos; primary productivity; the influence on the Niagara River flow in the lake's bio-chemical characteristics; the influence of the thermal bar on populations and productivity; detailed nutrient and other chemical budgets of the lake; the use of metals and ions as water movement and dispersion tracers; and, finally, the extension of the work in representative basins within the watershed to include a consideration of the impact of basin geology and land use on nutrient and other chemical inputs to the lake. The interest of university, government and industry biologists, chemists and geochemists is now being co-ordinated to develop the scientific details of this program.

A plan for the Canadian IFYGL Data Bank is being prepared by the Co-ordinator and the CCIW Computer & Data Services Section.

During the year the Co-ordinator, Mr. J. MacDowall, also acted as Vice-Chairman of the Sensor and Instrumentation Working Group of the Canadian National Inter-Agency Committee on Resource Satellites and Remote Airborne Sensing. Contracts were solicited, placed and monitored for the development in Canada of new remote sensing with a wide range of application in earth resources and environmental monitoring.

Central Region (Marine Sciences Branch)

The Marine Sciences Branch involvement at the Centre increased enormously in 1970 with the relocation of the Hydrographic activity of Central Region and the Regional Headquarters at Burlington.

HYDROGRAPHY

A field unit provided survey control and supplied and maintained navigational systems in support of Limnogeology Section programs. The support of these units also included calibration of the Minifix and Motorola systems and the production of suitable lattice charts as necessary.

The charting program of the region was continued in the Lower St. Lawrence River between Cap du Basque and Murray Bay to produce modern nautical charts for the use of commercial deep draft shipping; in the Thousand Islands area for the use of both commerce and recreational boating; and at Lake of the Woods, the Rideau Waterway, the Lake of Two Mountains for the primary purpose of producing recreational boating charts in response to public demand. In addition hydrographic surveys of small fishing harbours, were carried out on the eastern shore of Lake Superior, and many charts in Lake Superior and Lake Huron were revised and updated as part of the revisory survey cycle. Navigational ranges were surveyed in the Sorel-Quebec City

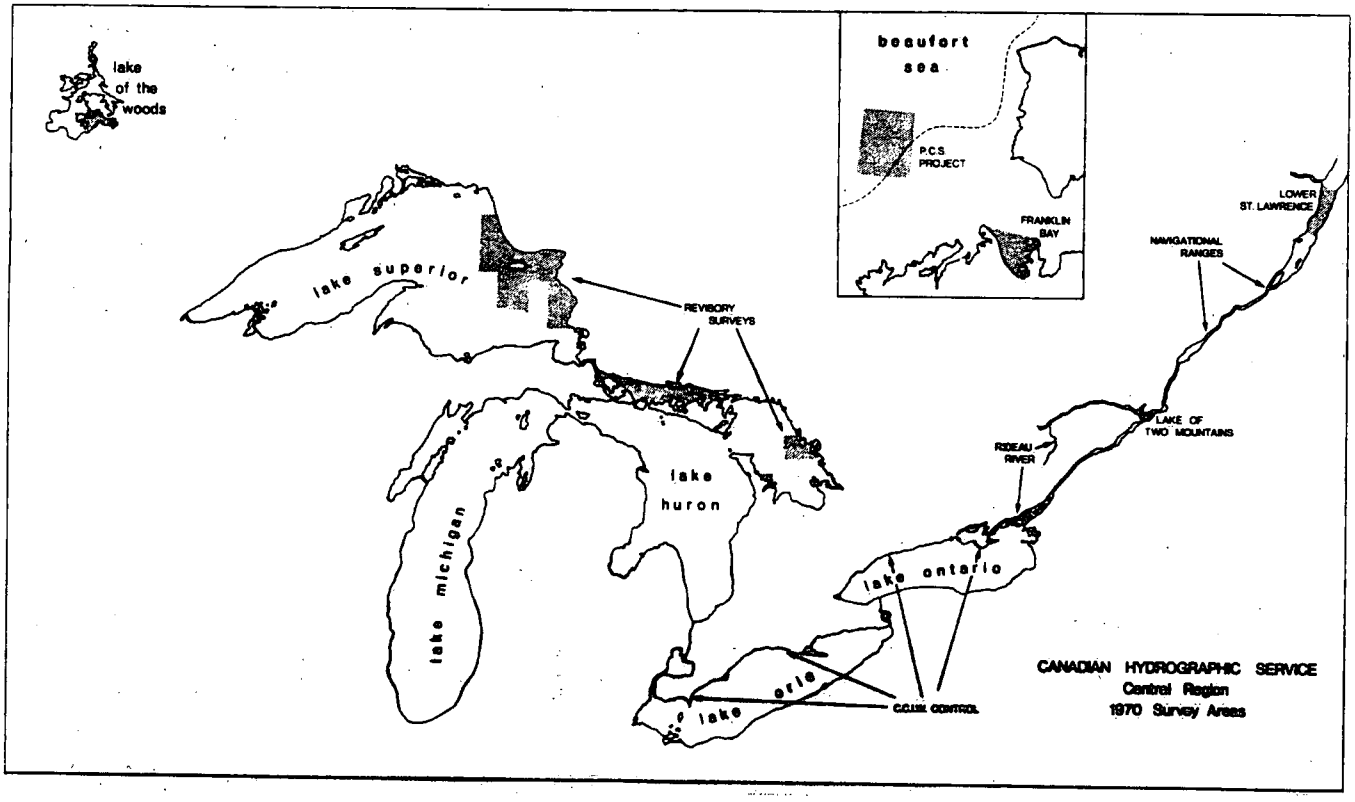


Figure 16.

area. A field unit supported Polar Continental Shelf projects in the Beaufort Sea, by carrying out bathymetric "through the ice" surveys over the continental shelf in winter, and a hovercraft survey operation and evaluation in Franklin Bay during the short summer (Figure 16).

Other hydrographic activities include preparation for IFYGL by establishing sites and survey control for the use of a navigational system covering Lake Ontario, evaluation of "accurate ranging radar" and a new type of pulse sonar.

The development group have been evaluating the Motorola system and are presently involved in a Loran C study of Lakes Ontario and Erie in conjunction with HPL Engineering Ltd. of Ottawa. In the field of data processing they have acquired a PDP 8 computer and a Gerber 22 Plotting Table and now have, for the first time, all data processing units under one roof. During 1970 all survey data used or produced by this unit and considerable additional data were processed for other field units.

SHIPS AND LAUNCHES

After completing her winter mooring schedule, MARTIN KARLSEN commenced her full time operational season March 23, continuing her predominantly monitoring operation until December 19 and suffering virtually no down time.

LIMNOS also opened the season March 23 and carried out a variety of specialized projects. She remained in service until December 14, experiencing very little down time, a much improved performance over previous years.

RADEL II, in her first operational year at CCIW saw only limited service, due mainly to her limited range and overall capability.

LAC ERIE, assigned principally to Limnogeology, enjoyed another active season from April 6 to December 22. LAC ERIE participated in the trials of the chartered D.N.D. Submersible PISCES III, supported by a branch helicopter and C.S.L. BRUCE.

Four launches were retired from service, three of them wood displacement hulls. These were replaced by Botved launches, perhaps the most suitable type of sounding launch readily available. A total of seven of these were acquired to maintain hydrographic field strength. For scientific operations, two vessels were acquired, a second Alcan 44 foot launch AGILE and a 40 foot tug W.R. MORGAN. The Alcan was found to have serious hull defects and will require extensive modification. W.R. MORGAN was acquired late in the year and will not be placed into service until 1971.

Construction was started on C.S.L. VEDETTE, a 45 foot revisory survey craft. Completion was considerably delayed, however, and the vessel is not expected to be ready for service until May, 1971.

In mid-season, the Branch accepted responsibility for the operation and maintenance of WASUCA III, a 32 foot twin-hull launch owned by the Guelph office of the Water Survey of Canada Division, Inland Waters Branch.

The Marine Workshops were occupied during the summer of 1970 and by the end of the year they were in full operation. A number of hydrographic launches and small craft were brought to the Centre for repair and refurbishment and at the close of the season the number of hulls on the premises totalled 58.

ADMINISTRATION

The administrative support section provided budgeting, financial control, auditing, payroll, personnel, secretarial, stores and procurement services to the region. With a manpower total to service at peak in excess of two hundred and fifty and funds to administer in excess of $3.5 million, the section is kept fully occupied in ministering to regional demands.

Hydraulics Subdivision, Hydrologic Sciences Division (Inland Waters Branch)

The Hydraulics Subdivision started the year in Ottawa and moved to the Canada Centre for Inland Waters in August 1970.

Much of the earlier part of the year was devoted to planning to ensure that the proposed hydraulic laboratory at CCIW will be as versatile and as efficient as possible while keeping costs within the budget.

The chosen areas for hydraulic activity total 7 in all. These are: Calibration and Testing, Waves and Interface Studies, Sediment Transport, Fluid Dynamics, Ice, and

Model Studies. A considerable amount of time was devoted to designing large pieces of apparatus for each of these areas so that the building when completed would be able to accommodate them. Among the problems encountered were in the design of a large wind-wave flume and the formulation of research equipment for sediment transport studies. Other considerations were the layout of large environmental rooms for studies of ice and thermal phenomena in rivers and lakes.

Planning calls for construction to begin in April 1971 and it will take about one year to complete the structure.

One of the major responsibilities of the Subdivision is to make provision for a national calibration centre for river, lake and oceanographic current meters. During the year the Subdivision prepared the specifications for the towing carriage which will be used on the 122 metre long towing tank. Tenders were sent out for quotation in November. The carriage will be semi-automated and will embody modern control and data acquisition systems. Salient performance specifications are –

Minimum Steady Velocity	0.5 cms/sec
Maximum Steady Velocity	6.0 metres/sec.

The allowable variation in velocity is ± 1%.

During the year, the Subdivision also undertook a laboratory model study of the wave agitation in the CCIW harbour and published a report. The model studies were done in the Coastal Engineering Laboratory at Queen's University through the kind permission of Dr. A. Brebner, Head, Civil Engineering Department. Mr. J.A. Marsalek performed the tests.

In September, Dr. Y.L. Lau joined the Subdivision and began work immediately on the waste heat discharge problem as it relates mainly to rivers. The objective is to obtain an accurate method of calculating the temperature downstream of a hot water source under any conditions of river flow, depth, breadth and roughness and also the atmospheric conditions such as air temperature and wind velocity. So far the work is in the preliminary stages but several poorly known parameters such as evaporation from flowing water have been identified.

Related to thermal pollution is the problem of the reaeration of rivers and the rate at which oxygen can be supplied. Studies have begun into the relationships between the rate of reaeration and the hydraulic parameters describing the flow. In addition methods of enhancing the rate of reaeration are being investigated.

At the end of the year, a working group of the Advisory Committee to the Canada Centre was being organized to provide guidance on research priorities in hydraulics at the Centre.

During the year the Subdivision also worked closely with R.J. Kennedy and Associates on various equipment designs and on the preparation of specifications. Model tests were run at Queen's to obtain the optimum design of a large sediment trap for the sediment transport flume.

Water Quality Division (Inland Waters Branch)

During 1970 the Water Quality Division, Inland Waters Branch, was represented by two groups at CCIW, Analytical Chemistry Laboratories, and part of the Water Pollution Research Subdivision. This annual report is divided into these two main sections.

ANALYTICAL CHEMISTRY LABORATORIES

In keeping with its responsibilities for the co-ordination, planning, organization and conduct of chemical analyses of lake waters for water quality and pollution studies, as well as research and development of analytical methods for these waters; the CCIW analytical laboratories had a very busy schedule during 1970. As in the past, the detachment was actively involved in the co-ordination of analytical requests; the chemical monitoring of the Great Lakes waters and Georgian Bay, as well as providing analytical support to various other sections and/or agencies at CCIW and elsewhere.

Major projects for the year consisted of the following:

Regular Monitoring

A total of 17 full chemistry monitor cruises were completed during the year. Of these, 10 were conducted on Lake Erie, 3 on Lake Ontario and 2 each on Lakes Huron and Superior. During these cruises, approximately 3,800 water samples were analyzed aboard ship for orthophosphate, soluble reactive silica, nitrate + nitrite, ammonia and 5,000 for total alkalinity (Figure 17). A total of about 19,000 samples were analyzed for specific

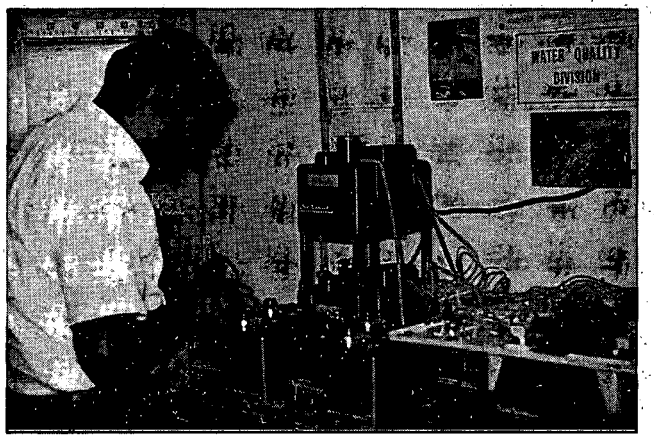


Figure 17. Multiple – Channel Auto Analyser system aboard the M.V. Martin Karlsen for simultaneous nutrients analyses of lake waters.

conductance and turbidity, 18,000 for dissolved oxygen and 16,000 for pH by the Technical Operations Section personnel. Instruments, reagents and technical supervision of these analyses were provided by the Water Quality Division detachment staff. Approximately 6,200 samples returned to the shore laboratory were analyzed for total phosphate and total organic nitrogen. An additional 1,980 samples were analyzed in the shore laboratory for calcium, magnesium, sodium, potassium, sulphate, chloride, bicarbonate and 800 for cadmium, chromium, cobalt, copper, total iron, lead, lithium, manganese, molybdenum, nickel, vanadium and zinc by atomic absorption spectrophotometry using solvent extraction techniques. Approximately 300 samples collected from Lakes Erie, Ontario, Huron, Superior and St. Clair at selected locations were analyzed for mercury.

Bioassay Studies

Analytical support was provided to the Fisheries Research Board detachment at CCIW in its bioassay studies. A total of about 650 integrated water samples collected from Lakes Ontario, Erie and Huron were analyzed aboard ship and in the shore laboratory for soluble and total nutrients including total organic carbon, total alkalinity; 300 for major ions and 1,300 for trace elements.

Water Quality Network

The sampling and analysis programs for the Water Quality Network were continued on the Great Lakes. Water samples collected from designated stations were analyzed for soluble nutrients, total phosphate, total organic nitrogen, major ions and trace elements as part of the total lake monitoring program.

Georgian Bay Project

In collaboration with the Great Lakes Institute of the University of Toronto and Technical Operations Section of the CCIW Lakes Division, the C.C.G.S. PORTE DAUPHINE was equipped by the Water Quality Division detachment to undertake four monitor cruises on Georgian Bay. Operational and technical instructions, reagent supplies, sample bottles and other necessary equipment were provided by the detachment for the study, the purpose of which was to obtain base line water quality information on Georgian Bay. A total of approximately 380 water samples were analyzed aboard ship by the Great Lakes Institute personnel for dissolved oxygen, turbidity, pH and specific conductance. Also, about 380 water samples were collected and returned to the Water Quality Division detachment shore laboratory where they were analyzed for soluble nutrients; 760 were analyzed for total phosphate, total organic nitrogen and 300 for total alkalinity, major ions, total organic carbon and trace elements.

Thermal Bar Study

Analytical support was provided by this detachment to the Chemical Limnology Section of Lakes Division in its Thermal Bar Studies on Lake Ontario. A four-channel auto analyzer system was installed onboard the CSS LIMNOS and water samples were analyzed aboard ship and in the shore laboratory for total and soluble nutrients, major ions and trace elements.

Hypolimnion Study

The detachment also participated in and supported the one month Hypolimnion Study on Lake Erie which was co-ordinated by the Chemical Limnology Section. A six-channel auto analyzer system was installed on the LIMNOS and about 5,700 tests for orthophosphate, soluble reactive silica, nitrate, nitrite, ammonia, filtered and unfiltered alkalinity were completed by the Water Quality Division detachment personnel.

Rain Water Chemistry

The Chemical Limnology Section continued, throughout the year, to collect rain water samples which were analyzed by the Water Quality Division detachment laboratory. A total of approximately 130 such samples were analyzed for pH, total and soluble nutrients, total alkalinity, major ions, copper, lead, zinc, cadmium and total iron.

Interstitial Water Analysis

A number of interstitial water samples collected from lakes sediments by sections of the Lakes Division were analyzed by this detachment for major ions, total alkalinity

and trace elements.

Air Sudbury Project

As part of the studies on precipitation of pollutants and to determine the importance of atmospheric contributions to northern Ontario lakes, this detachment collaborated with a number of agencies in the Air Sudbury program which commenced in June. Participants included the McMaster University Department of Geology, the Ontario Department of Lands and Forests in Sudbury and the Ontario Water Resources Commission. A total of 50 rain samples collected in the Sudbury area were received and analyzed in our shore laboratory for cadmium, chromium, cobalt, copper, total iron, lead, manganese, molybdenum, nickel, vanadium and zinc.

Round Robin Series

As part of the Water Quality Division program to check and maintain uniformity of methods and techniques in all of its laboratories across Canada, the CCIW detachment also participated in this study, the purpose of which was to compare performance and obtain data on precision in participating laboratories.

Special Studies

(i) A number of samples were received and analyzed for certain constituents in support of the McMaster University study of emissivity of water surfaces.

(ii) Again this year, a special study was conducted on the Hamilton Bay water. Samples collected from strategic locations in the bay were analyzed for various constituents.

(iii) On five separate occasions, special investigations and trials were conducted on Lake Ontario and the Hamilton Bay with the Hydrolab and Plessey Submersible water quality monitor systems. The Plessey Submersible was moored at selected locations in the lake for the continuous recording of water quality data (pH, dissolved oxygen, specific conductance, turbidity, temperature, time and depth) (Figure 18). A total of approximately 600 water samples were analyzed with both instruments and the data compared with that obtained by the usual manual methods.

(iv) Special investigations were conducted to study what effect filtration of water samples may have on the actual sample composition.

Instruments and Methodology Development

(i) With the co-operation of the Engineering System Section of CCIW, the Hydrolab water quality analyzer and the Plessey Submersible water monitor systems were calibrated and standardized for use.

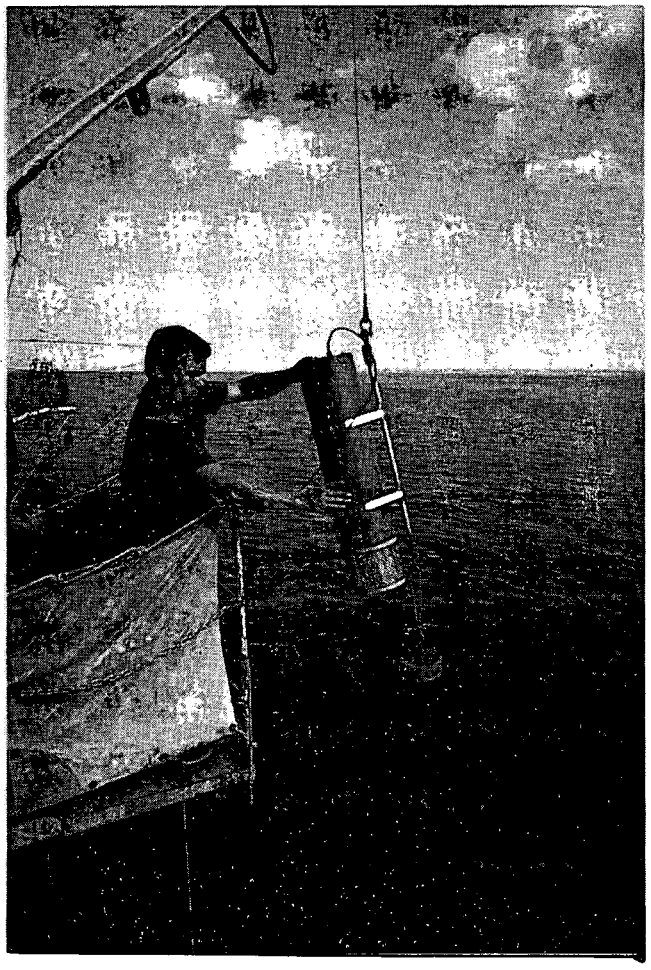


Figure 18. Plessey Submersible water quality monitoring system under test on Lake Ontario.

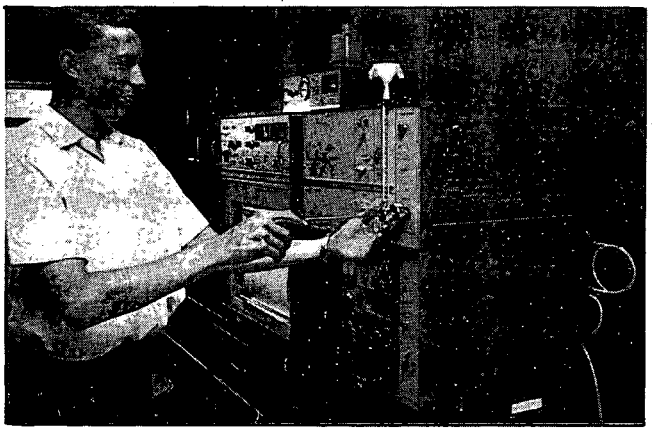


Figure 19. CHN Analyser for shore-lab determination of carbon, hydrogen and nitrogen in particulate samples.

(ii) A new model 403 Perkin-Elmer atomic absorption spectrophotometer was acquired and put into operation to alleviate the heavy workload demands previously on our single instrument.

(iii) A Hewlett-Packard CHN analyzer (Figure 19) and a Fisher-Hamilton gas partitioner were also obtained and calibrated for laboratory use.

WATER POLLUTION RESEARCH SUBDIVISION

The Water Pollution Research Subdivision of the Water Quality Division is primarily concerned with efficient and economical methods of pollution abatement and renovation of wastewaters arising from municipalities and industries across Canada. Besides undertaking a limited number of its own studies, the Subdivision has responsibilities to encourage, to co-ordinate, and to contract for both university and industrial research across Canada related to water and wastewater treatment. The headquarters of the Subdivision will be moved from Ottawa to CCIW upon completion of the Water Quality Pilot Plant in mid 1971.

During 1970 the activities of the CCIW Detachment of the Water Pollution Research Subdivision centred around the Water Quality Pilot Plant under construction, which will have modular treatment facilities for applied research on new and improved processes developed in the laboratories of the Centre and elsewhere. In late winter and early spring, meetings were held with the architects and engineers during the conceptual and final design stages. In June, The Grunwell Associations Limited submitted its preliminary report on the pilot plant facilities. The proposals contained in the report were subsequently reviewed by the Working Group on the Water Quality Pilot Plant, an advisory subcommittee of the ACCC composed of technical representatives from two provinces, universities, industries, consulting engineers, and federal departments. The Working Group was formed to advise on such aspects as equipping the pilot plant, research priorities, specific research proposals, and allocation of space and facilities. In August a contract was awarded to Bramalea Contracting (Peel) Limited, for completion of the Water Quality Pilot Plant by June 1971. In October, The Grunwell Associates Limited were retained to prepare plans and specifications for the pilot plant equipment to be purchased and installed up to December 1972. A number of meetings were subsequently held with the consultant regarding equipment purchases in the 1970-71 fiscal year.

Besides preparing for the Water Quality Pilot Plant, staff concentrated on current fundamental and engineering research on the removal of phosphorus and nitrogen from municipal wastewaters. Visits were made to the major advanced wastewater treatment plants operated by the FWQA in the eastern U.S.A. and southern California. The 5th International Association on Water Pollution Research Conference and the Water Pollution Control Federation Annual Meeting were attended for their programs in this area of research. State of the art papers on both phosphorus and nitrogen removal are presently being prepared as a conclusion to these investigations.

Similarly in the water treatment and water renovation field the reverse osmosis process received considerable study and evaluation. The American Water Works Association Annual Meeting was attended and potential suppliers of reverse osmosis equipment in Canada were contacted. Presently a research proposal is being prepared for a possible study on saline well-waters in the Prairie provinces.

During the year reviews and recommendations on research proposals by the private sector dealing with water and wastewater treatment were made to the National Advisory Committee on Water Resources Research Secretariat. Staff also served on the NACWRR Site Visiting Committee considering the University of British Columbia Development Grant proposal to establish a Water Resources Research Centre and acted as a liaison officer on a contract with the Canadian Canners Limited Research Centre in Burlington, Ontario, for research on the movement of pesticides and fertilizers resulting from the annual treatment of sweet cornfields.

In 1970 the Subdivision was directly concerned with a number of other contracts and research projects involving the university and private sectors. The Division contracted with James F. MacLaren Limited, Consulting Engineers, for a report on "Removal of Iron, Manganese and Sulphide From Well-Waters for Rural Supplies". Through the Centre a contract was awarded to the University of Toronto for research on a partial nutrient removal system (phosphorus and nitrogen) to be conducted at the Town of Penetanguishene activated sludge plant. Staff served as advisers to Central Mortgage & Housing Corporation on its research contracts with the Ontario Research Foundation on the process for wastewater treatment in an enclosed environment and Prosearch Limited on sewage treatment plant design. At the end of the year, the Division was invited by the Town of Burlington to participate in a joint study to be conducted at the Skyway Water Pollution Control Plant on phosphate removal. This will be a co-operative research project conducted by James F. MacLaren Limited, Consulting Engineers for the Town of Burlington with assistance from Ontario Water Resources Commission and CCIW.

In addition to the programs already cited the Subdivision staff at CCIW were active across Canada in a number of areas. These included membership on the Waste

Treatment Task Force of the Okanagan Study Committee; the presentation of a paper on the "Aims and Programs of the CCIW" at the Calgary Annual Meeting of the Canadian Institute for Pollution Control; membership on the Treasury Board Utilities Processes Subcommittee on Sewage Treatment Plants in Ottawa; and visits to environmental engineering professors at the University of New Brunswick and Nova Scotia Technical College.

Resources Research Centre (Policy Research & Co-ordination Branch)

The year 1970 was the first year of full operation of this unit, the Lakes Management Section, Policy Research and Co-ordination Branch. The Section has responsibility for a social and economic research program into problems of lakes management and water use in the Great Lakes Basin. In addition, the unit performs a number of support functions to the CCIW.

The major focus of the Section's activities have been directed towards the development of an overall research strategy within which to analyze water use management problems and the undertaking of a number of initial research projects, on aspects of water use, improvement of the availability of water use data, public attitudes towards water use problems and institutions for lake management. A considerable proportion of the Section's activities have been conducted in support of other operations at the CCIW, both in research and administration.

The Section has assumed responsibility for secretarial duties for the Advisory Committee to the Canada Centre (ACCC) and its working groups. It provides also, liaison with the Great Lakes Basin Commission, the U.S. federal-state agency responsible for comprehensive planning in the Great Lakes Basin. The unit furnishes representation on a number of inter-departmental committees and task forces.

The major research projects undertaken during the year have centred around the wide economic implications of environmental quality management in relation to the use of the water resource for the disposal of wastes and public knowledge of and attitudes towards major water management problems. An attempt has been made and is continuing to upgrade the quality and availability of basic data on water use.

The investigation of the use of potentially environmentally harmful substances in the Great Lakes Basin has developed into a major research project and it is expected that the study will be extended to all Canada. Preliminary work was done during the year on a number of heavy metals, PCB's and the use of pesticides in agriculture. A number of draft reports have been prepared but data difficulties have hampered the production of definitive information.

During the summer of 1970 a survey was made of the extent of knowledge of the detergent phosphate problem among a sample of Hamilton housewives and of their attitude towards the regulation of the phosphate content of detergents. The analysis of the information is not complete but it appears that few housewives were well informed and that concern varies directly with social status.

A Water Use Map of the Great Lakes is nearing completion and all the essential information from both the United States and Canada has been collected. This project has largely been done for the Resources Research Unit by the Economic Geography Section, Policy Research & Co-ordination Branch. It is planned to publish the map in the spring, 1971.

A peripatetic program of restricted investigations into the changing pattern of economic and related urban development in the basin has formed a significant part of the Section's activities. Observed trends have been evaluated for impact on the water resources. The most significant projects in this area includes an investigation of municipal waste treatment cost variations, analysis of possible beneficial applications of waste heat and the effect on the water resource of alternative distributions of future population and economic activity.

Public Health Engineering Division (Dept. of National Health and Welfare)

GREAT LAKES STUDIES

Between May and November 1970, the Department of National Health & Welfare bacteriological personnel participated in eight monitor cruises on Lake Ontario, Lake Erie and Lake Huron. These cruises were part of a long-term monitoring program designed to determine the presence, concentration, extent and sources of bacteriological pollution within these lakes (coliforms and other indicator organisms). Determinations of the bacterial concentration, which is related to lake productivity were based upon the density and the biomass.

GREAT LAKES RESEARCH

Two major bacteriological studies within Lake Ontario and Lake Erie were completed during 1970-71. These were part of a continuing co-operative project undertaken jointly by scientists from the Department of National Health and Welfare and the Department of Energy, Mines and Resources. These studies were:

(a) Preliminary bacteriological investigation of the Lake Ontario thermal bar and its effect on confining effluents, waste discharges and nutrients originating from rivers, landwash and outfalls to the nearshore areas of Lake Ontario; and

(b) Microbiological studies of nutrient regeneration and oxygen depletion processes in the central basin of Lake Erie.

BACTERIOLOGICAL SEDIMENT ANALYSIS PROGRAM

During 1970 a detailed sediment sampling program was undertaken in the Kingston Basin and St. Lawrence River outlet of Lake Ontario in conjunction with the Limnogeology Section of the Canada Centre for Inland Waters. From this study bacterial density and biotype distribution patterns in the sediments were obtained. The effect of various local factors, such as sewage treatment plants, industries and farming areas on the density and biotype distribution patterns were investigated.

Environmental Quality Co-ordination Unit

The EQCU co-ordinates the results of research produced by the various disciplinary groups of the CCIW and prepares reports recommending policies on water quality and methods of controlling pollution. The Co-ordinator advises the Director of the Centre on pollution research and on development of programs in this field. He assists in providing liaison with provincial and federal abatement agencies and with our counterparts in the United States. Work continued on a Federal Contingency Plan and on the Interdepartmental Working Group on Pesticide Research in the Great Lakes. New projects included co-ordination of an evaluation of the impact of NTA on the environment, and chairmanship of the Scientific Advisory Committee of CCIW and of the Technical Working Group for the Federal Contingency Plan.

Work on the Federal Contingency Plan for combatting oil and other toxic material spills was greatly accelerated during the year due to the grounding of the tanker "Arrow" in Chedabucto Bay early in the year. Activity directly related to oil spill Contingency Plans accounted for a major portion of the activity within the Unit during the year. The Co-ordinator and F.M. Boyce of Physical Limnology Section assisted in the early days of the Arrow affair by supervising the testing of a burning technique for the removal of the oil and evaluating the use of straw as an oil absorbent. In June, the Co-ordinator flew to Fort Chipewyan on Lake Athabasca to observe the clean-up efforts there as a result of a spill of synthetic crude into the Athabasca River at Fort McMurray. In both instances the experience gained by on-site participation and observation was useful in producing the final versions of the Interim Federal Contingency Plan and the Field Manual being prepared for use by the On-Scene Co-ordinators under the Federal plan.

Early in 1970 the Co-ordinator was appointed Chairman of the Technical Working Group under the proposed Federal Contingency Plan. This Working Group was responsible for the production of a Field Manual containing

descriptions of clean-up methods for oil and toxic substances in various circumstances. Membership is drawn from all interested federal departments and private industry.

During the summer of 1970 the Interim Interdepartmental Committee on Contingency Planning was formed. This Committee, under the chairmanship of Captain William Stuart of DOT, produced the Interim Federal Contingency Plan which was officially promulgated in the fall. The Director of CCIW is named in the Plan as Regional Co-ordinator for the Great Lakes region and the EQCU has been active in support of the Director in developing the detailed planning for the Great Lakes region.

The Interdepartmental Working Group on Pesticide Research in the Great Lakes met twice during 1970 and continues to co-ordinate the development of research programs and proposals. The first research program developed by the Working Group was initiated during the year with the monitoring of pesticides in Lakes Erie and Ontario. The 1970 cruise program placed major emphasis on the establishment of proper sampling and analytical techniques with replications of water and biota samples at single stations. A small number of single sample stations throughout the lake gave preliminary estimates of the distribution of these pollutants. To date, only water samples have been analyzed and these were uniformly below the level of detectability. The second phase of this program will be carried out in 1971 cruises with emphasis on temporal and spatial variation of various pesticides throughout Lakes Erie and Ontario. Four new research proposals currently are under development by small task forces of the working group. These include the effect of pesticides on algal production, aerial transport of pesticides into the lakes, the interaction of pesticides with bottom sediments, and the sub-lethal effect of pesticides on aquatic biota.

The proposed substitution of NTA for phosphates in laundry detergents resulted in a massive research effort in Canada, U.S.A. and Sweden to evaluate the potential impact of NTA on the environment. The EQCU played an active role in the development of this program and in particular in co-ordination between research scientists and industrial representatives. Several meetings with representatives of the detergent industry and with the washing machine manufacturers' associations were held. Scientists from the United States and Sweden met with Canadian scientists at CCIW in December to exchange recent research data on this important subject. This led to recommendations against extensive use of NTA in detergents.

During the year the EQCU prepared papers on pesticide registration procedures and "A Canadian Environmental Council".

The Environmental Quality Co-ordination Unit assisted the Director of CCIW in co-ordinating the scientific program by providing the Chairman and Secretary for the Scientific Advisory Committee (SAC), which considered major problems of common interest on water resources management and recommended to the Management Committee scientific policies and programs to provide the information needed to solve these problems. SAC reviewed research programs of the various detachments and sections so as to achieve a full exchange of information and, where desirable, the co-ordination of effort. The Unit provided leadership in the development of a co-ordinated preliminary cruise report procedure and for a CCIW Task Force on Oil Pollution Research. In December it was decided the functions of SAC would be divided between subcommittees of the Management Committee and a new scientific council which will be representative of the body of professional staff at CCIW and deal with subjects of concern to those professionals such as seminars, library and publications.

The Co-ordinator represented CCIW on a number of interdepartmental committees and working group including the Interdepartmental Working Group on Water Quality Networks, the Advisory Committee to the Saint John River Basin Study, the Working Group on Nutrients, and Energy, Mines & Resources Departmental Committee on Oil Pollution. In addition, he serves on the Sub-Group on Contingency Plans of the U.S.–Canada Working Group on Great Lakes Pollution.

Liaison was maintained with several international associations by participating in a number of conferences and symposia including the American Water Resources Association, the Water Pollution Control Federation, and the Committee on Concerns of Modern Society of NATO in Brussels.

Engineering and Scientific Support Division

The Engineering and Scientific Support Division provides the major portion of the technical and professional support required for the scientific programs at the Centre. It consists of four sections and is concerned primarily with

providing the following:

(a) the development, design and production of prototype instrumentation for a specific scientific requirement,

(b) the research on methods of obtaining samples and monitoring physical, chemical, geological and biological variables, and the development of the resulting instrumentation,

(c) specialized scientific services required on an occasional basis by all research groups, or which by virtue of equipment costs or special operating and servicing requirements, are impractical to provide on an individual basis to research sections,

(d) research in new techniques for sample analysis or uses for the scientific equipment,

(e) suitable computer facilities on site or by rental agreements,

(f) the quality control and storing of original data and provision of programming expertise,

(g) reference library facilities to research groups at the Centre.

The activities of each section are discussed below.

ENGINEERING SYSTEMS

Generally, the Section provides engineering services to all divisions and agencies of CCIW, including the design, development, instrumentation and maintenance of limnological and water resources instrumentation systems and automatic data acquisition and processing systems. A description of some of the more interesting projects and activities in 1970 follows.

Fixed Temperature Profilers

These are data acquisition packages for obtaining time-series temperature profiles at various fixed locations in the lakes. The package itself is submersible or can be mounted on a surface buoy or platform. Twenty thermistors are attached to a cable which is connected to the profiler, thereby providing temperature information at 20 depths below the unit. The information is recorded as digital numbers on a magnetic tape recorder contained within the profiler package. The unit has sufficient power to measure and record these temperatures every 10 minutes for 8 weeks.

Triple Corer

In the course of geochemical investigations of silts and muds, a sampler was required that could operate to a depth of 400 metres and accurately core a sufficient quantity of material for a layer by layer analysis of the lake sediments. An instrument has been developed based on the standard Benthos corer, but consisting of a cluster of three coring tubes contained within a cylindrical support housing. Different lengths of coring tubes can be easily attached to the unit. Commercially available Benthos valves are used to retain the core samples but the valve release mechanism is an in-house design. A special screw-type core extruder has also been produced for use with the triple corer.

Meteorological Packages

Initially developed last year, the "met pack" systems are remote stations capable of recording meteorological data in situ on magnetic tape. In a continuing development program, these systems compared favourably with D.O.T. Met. Branch instruments. Comparison tests were also conducted between buoy-mounted packages and identical packages mounted on fixed towers. From the results of a successful 40-day trial, the design of the packages has been fixed, and procurement action for sufficient units to maintain 11 buoy-mounted packages on Lake Ontario during the International Field Year on the Great Lakes (1972) has been initiated.

Water Sampling System

Development began on a system designed to obtain samples from a water column to a depth of 30 metres. The equipment consists of a submersible pump, umbilical cable, surface handling equipment and a plumbing system. When used in conjunction with an electronic bathythermograph (see below) the system is capable of far greater resolution and accuracy in obtaining water samples than standard bottle casts, as shown by repeatability tests. To supplement standard chemical analysis techniques automatic water quality probes can be immersed in the sample hose outlet jet. Since the volume of water sample obtained is large compared to bottle casts, and since an analysis can be repeated if necessary, the confidence in data points is greatly increased.

E.B.T.

The Electronic Bathythermograph (E.B.T.) is a device for producing a vertical temperature profile of a column of water. This device was originally developed in-house, but modified in consultation with Dr. Dauphinee of NRC and Guildline Instruments Ltd., Smiths Falls, Ontario, who were awarded a contract to manufacture an initial quantity of three units. The accuracy of the sensor system is 0.02°C over a 30°C range and 0.1% of depth. However, the present readout system is an X-Y chart recorder which limits the readout accuracy to 0.1°C and 0.25% of depth range. We have two configurations, one for use from launches

employing a hand winch, which limits the depth to 100 metres; the other configuration is a permanent ships installation with power winch, permitting recordings to 400 metre depths.

Dye Diffusion System

Engineering assistance was provided to the Physical Limnology Section in support of their simulated outfall diffusion studies (OSEX). The system uses a fluorescent tracer dye (Rhodamine B) which is released from a controlled source, 20 metres deep. The resulting plume is traced and can be spot-sampled at depths to 50 metres or continuously sampled at any depth between 20 metres and 6 metres via a towed hose and pumping system, and between 6 metres and the surface with an immersed streamlined boom having 6 discrete sampling points. The dye injection system is on a moored pontoon boat having a 200 gal. dye tank, a 3.5 KW diesel generator and several pumping systems.

SCIENTIFIC SERVICES

Since this is a relatively new Section, in operation only three months, much time was spent on planning of the facilities and initiating procurement action for various items of scientific equipment.

Two new laboratories are in the process of becoming operational. The Radiochemistry Laboratory is being equipped for low-level β-ray counting and γ-ray spectrometry in order to study the distribution of radio-active nuclides in lake sediments as a first step in contributing to the present programs underway at CCIW. The Electron Microscopy Laboratory has recently received a Siemens high resolution transmission electron microscope which will be used in the study of sediments and biological specimens.

COMPUTER AND DATA SERVICES

The Computer and Data Services Section has the responsibility for planning and implementing data processing systems for CCIW. The Section has three main units: The Computer Applications unit which develops software systems and assists scientific staff in implementing their programs; the Computer Systems unit which schedules and operates the on-site hardware; and the Data Preparation, Storage and Retrieval Unit which processes and quality checks manually collected data.

The Section has two small computers; a PDP 8/S which is used primarily to translate instrumentation tapes to computer compatible magnetic tape, and a larger PDP-9 which is used for special applications. These applications include 3–D and contour plotting, analog to digital conversion, paper tape conversion, data quality control and experimental programming languages. A Control Data 200 User terminal, connected to a CDC 6400 at McMaster University, is leased and provides a very useful extension to our facilities. This year, in excess of 10,000 jobs were run through this terminal to McMaster, taking approximately 3360 min. of Central Processor time. A library of 250 reels of magnetic tape is maintained on which our original data are stored. A teletype timesharing service from COMSHARE was installed and is undergoing a feasibility study.

During 1970 data from 27 scientific cruises on the Great Lakes were processed. Computer generated reports and analyses were provided. Additional historical data on Lake Ontario current movements were obtained from U.S. Federal Water Quality Administration and added to CCIW's data base.

Some of the software developed for use at the Centre are,

- Geodyne current meter statistical analysis package,
- CZAR, a comprehensive time series storage and retrieval system,
- a report generating and quality control program for storage and retrieval of our monitor cruise (STAR) data,
- Quality Control programs for the shipboard data logger,
- an extensive program package for Project Hypolimnion.
- analysis programs for the Towed Thermistor chain,
- programs for analysis of data from the buoy-mounted meteorological packages.

Programs that have been implemented, but developed elsewhere, include

- 3-dimension and contouring routines,
- general purpose contouring package,
- cluster and factor analysis,
- non-linear least squares curve fitting program,

and those obtained by contract with McMaster University are a

- STAR storage and retrieval system, and
- STAR data editing and quality control.

LIBRARY

During 1970 the library continued to develop in support of CCIW's research program. Fifteen hundred books were added to the collection; subscriptions continued to 800 journals plus 170 data reports, abstracting

services and other similar items. The library obtained on inter-library loan over 1,000 items for scientific staff which were from a variety of older journals and their frequency of use does not justify our purchasing back volumes. Our usefulness to other libraries is also increasing; one hundred items from our collection were loaned to libraries from Newfoundland to Alberta. Our list of serial holdings will appear in the next edition of the Union List of Scientific Serials in Canadian Libraries, and at that time our collection should become even more useful to others.

Forty-two translations were made in 1970 for CCIW scientists by the Secretary of State's Translation Bureau. Information on these was given wide circulation resulting in frequent borrowing by scientists outside the Centre. Most of our other library facilities are also used extensively by students of local universities. Statistics kept in February 1970 indicated that an average of 60 persons per day used the library and the staff provided information in reply to an average of 22 questions per day.

Continuing library services include production and distribution of *Collected Reprints* volume 2, to exchange libraries; distribution of a bibliography of CCIW's staff publications; assistance in producing IFYGL bibliography; production of acquisitions lists; distribution of tables of contents of journals to staff members and production of a revised list of serial holdings. Three computer profiles are now operating in two different SDI programs. A program is being introduced to determine the length of time that journals should be retained in the collection.

At one of our Library Committee Meetings information retrieval was discussed. At the present time appropriate abstracting and indexing services are provided for scientists or computer profiles are submitted for them. In the future, more sophisticated information retrieval systems are planned.

Public Relations and Information Services

Mercury, phosphates, NTA and the Canada Water Act were among the words and phrases which grew in familiarity with the passing months of 1970. Pollution and water management gained new heights of popularity as subjects for speakers, for feature articles and for special broadcasting programs. In step with this interest and the increasing demand for stories and news of the research work of the Canada Centre for Inland Waters, the Public Relations Unit spent a busy but rewarding year.

Feature coverage was given the Centre by some of the country's largest daily papers. In television, the Centre graduated to network status as cameras from both Canada's national systems focussed on its work for feature programs. Company and corporate magazines also found the CCIW worthy of articles and special stories.

Increasingly, too, the Centre's staff met the public, often in person through public speaking engagements, or through the broadcast interview. The "open line" radio program also recognized the importance of the Centre's work when on two occasions, the Director of CCIW occupied the guest's chair to discuss on the air the problems of modern water management and the role of scientific research in solving them.

Perhaps the Centre's most unusual source of publicity during the year though, was a tractor-towed float in an inter-provincial service club parade which proclaimed that the branch represented by the vehicle's riders came from "Burlington – Home of the Canada Centre for Inland Waters"!

Many events provided good opportunities to explain the Centre's work to an increasingly interested public. Among these were Burlington's "Let's Control Pollution Week"; the International Association for Great Lakes Research annual conference in Buffalo; "Operation OSEX" (Outfall Simulation Experiment) at Oshawa; the unfurling of the Centre's new logogram flag; "Project Hypolimnion"; the visit of the U.S. National Academy of Science; "Project Tomato"; Hamilton's "Survival Week"; and the official opening by the Minister of Energy, Mines and Resources of the CCIW Research and Development Building.

Audiences in service clubs, civic action groups, church groups, associations and other organizations addressed on the work of the Centre during 1970, numbered more than 2,000. The Public Relation Unit's school speaking program was accelerated to reach a total audience of more than 15,000 – a ten-fold increase over 1969.

As the year closed, preparations were in hand for construction of a major exhibit to be housed in the Centre's new Main Laboratory Building. Work on a library of colour transparencies was well advanced and a photo library was in the planning stages. Also planned was a film on the CCIW for presentation to audiences in the Centre's theatre. A new slide show on the Centre, titled "Everybody's War" had also been produced by the Unit and was virtually complete at year's end.

Administration and Building Program

ADMINISTRATIVE SUPPORT

1970 brought an increase in the number and range of activities requiring central administrative support. Acceptance of the first set of new buildings involved phasing in a new telephone system; designing and encouraging the use of a centralized stores system; a major purchase of new office furnishings; planning and implementing the move into the new quarters and modifying the central registry service to meet the needs of both the increase in staff and the problems of the physical growth on the site.

The maintenance of equipment, buildings and grounds has become an increasingly complex function. Along with the growth in staff, facilities and programs, a site and field safety program has been organized and implemented. Initial development of a centralized purchasing service was begun in 1970 and it is expected that this will develop further in 1971.

In support of contract work performed by the private sector and the university community, the administrative support group was active in the development of contract formats and the general policy considerations attached to contract work.

BUILDING PROGRAM

1970 has been an important year in the construction program for the permanent buildings of the Canada Centre for Inland Waters. Three major buildings have been under simultaneous construction. The three separate contracts for these buildings were won by the Bramalea General Contracting (Peel) Ltd., at a total dollar value of $13,195,600.

On July 3, 1970 the warehouse and workshop elements of the first building contract were completed and personnel moved from the temporary quarters into these new facilities. The balance of buildings under this contract, the Research and Development building and the heating and cooling plant, were accepted on November 4, 1970 and were occupied immediately by additional personnel from the trailer complex. With the completion of this portion of the building program, the Centre's personnel now occupy nearly 160,000 square feet of permanent building area which was completed within budget and within 16 days of the targeted completion date.

The Centre's main laboratory and administration building was contracted on March 5, 1970. The scheduled completion date for the contract is March 31, 1972. The construction of this 8 million dollar building is, at present, two months behind schedule. However, completion on target is expected.

The Water Quality Pilot Plant contract was awarded on August 14, 1970 and completion is called for by June 14, 1971. The tenders for this building were first closed in April, 1970. However, the lowest tender was 26% over the budget estimate. Redesign was undertaken and the building was re-tendered. The contract now in hand is within our program budget. Construction work on the building is progressing well and completion on time is expected.

The Hydraulics Laboratory is the last building to be constructed under the program. Design of the building has now been completed and it is planned that construction will commence in April 1971 and be completed by December 1972.

Appendix A

CCIW Staff List

CCIW

Director, CCIW – J.P. Bruce

Secretary – Mrs. L. Ward-Whate

Executive Assistant to Director – T.S. Hillis

Building Services Superintendent – D.F. Stewart

Support Staff, CCIW – C.F. Hicks, A.W. Mayes, D. Niles, J. Slaz, Mrs. B.D. Titley, Mrs. E. Vos

Personnel Administration, CCIW – Miss R. Kelly, Mrs. M. Duggan, Mrs. C. Shepherd, Miss M.R.J. Warren

LAKES DIVISION (Inland Waters Branch)

Chief, Lakes Division – Dr. R.A. Vollenweider

Secretary – Mrs. S.M. Horne

Chemical Limnology Section

Head, Dr. Mary E. Thompson – specification electrodes; low temperature aqueous geochemistry

Secretary – Mrs. R.E. Morrison

Dr. N.M. Burns – physical chemistry of water; carbon cycle in lakes

Dr. Y.K. Chau – trace elements in the lake environment

Dr. A. Lerman – geochemistry of brines; radioisotopes in lake sediments

Dr. R.F. Platford – physical chemistry of aqueous solutes

Dr. W.M.J. Strachan – organic chemistry

Dr. R.R. Weiler – surface chemistry of sediments

Postdoctoral Fellow –

Dr. C.W. Childs – physical chemistry of aqueous solutes

Dr. J.O. Nriagu – economic geochemistry, authigenic minerals

Chemists –

M.E. Fox – soluble organic compounds in large lakes

H. Saitoh – trace elements

M.T. Shiomi – atmospheric precipitation chemistry; nutrient cycles in large lakes

Technical Staff – R.D. Coker, K.W. Kuntz

Biological (Fisheries Research Board)

A/Head, Dr. A. Nauwerck – zooplankton and phytoplankton taxonomy; zooplankton-phytoplankton relationships

Secretary – Miss L. Sully

Dr. W.A. Glooschenko – algal pigments and degradation products; effect of toxic substances on algae

Dr. M. Munawar (Post Doctoral Fellow) – phytoplankton species distribution

C.F. Carpenter – zooplankton biomass studies

J.E. Moore – primary productivity measurements; nutrient enrichment studies

H.F. Nicholson – fluormetric surface chlorophyll distribution

H. Shrivastava – bottom fauna

Technical Staff – R.H. Collins, H.H. Dobson (seconded from Environmental Quality Co-ordination Unit), J.K. Leslie

Senior Scientific staff of Freshwater Institute, Fisheries Research Board, Winnipeg, working on Great Lakes Problems: Dr. A.L. Hamilton, Dr. K. Patalas.

Physical Limnology Section

Head Dr. R.K. Lane – administration, remote sensing

Secretary – Miss C. Pinkerton

Dr. C.R. Murthy – diffusion, circulation

Mr. F.C. Elder – air-lake interaction, thermal effluents

Mr. F.M. Boyce – internal waves, heat content, oil slicks

Dr. J.O. Blanton – thermal structure, demonstration basin studies

Mr. P.F. Hamblin (educational leave) – circulation, seiches

Mr. D.G. Robertson – descriptive limnology, climatology

Mr. H.W. MacPhail – electronics

Mr. B. Kenney – diffusion thermal effluents, small-lakes

Dr. T.J. Simons – hydrodynamics, modeling

Dr. K. Thomson – remote sensing

Dr. E. Nagy – oil/water studies

Dr. H. Weiler (until 27 July 70) – circulation studies

Support Staff – D. Beesley, Miss J. Bond, R. Chapil, F. Chiocchio, Mrs. P. Greenway, Mrs. D. Jordan, W.D. McColl, K.C. Miners, W.J. Moody, H. Ng, H.K. Nicholson

Limnogeology Section

Head, Dr. P.G. Sly – distribution and variance of lake bottom sediments

Secretary – Miss J. Brouwers

Dr. C. Jonys – quantitative assessment of bedload transport and geohydraulic processes

Dr. A.L.W. Kemp – distribution and diagenesis of organic compounds in recent sediments

Dr. C.F.M. Lewis (GSC) – post-glacial uplift and stratigraphic correlation of recent sediments

Dr. N.A. Rukavina – interpretation of sediment distributions in the nearshore zone

Dr. R.L. Thomas – distribution, occurrence and authogenesis of minerals, major elements and trace metals in recent sediments

Dr. J.D.H. Williams – sediment/water interface exchange, with particular emphasis on the phosphate and iron cycles

J.P. Coakley – distribution, occurrence and relation to erosion, transportation and deposition of active sediments

C.G. Gray (educational leave) – diagenesis of recent organic compounds

W. Warwick (educational leave) – paleo-ecological interpretation of chironomid faunas

Technical Staff – W. Booth, G. Duncan (A/Chief Technician), Mrs. M. Hicks, Miss L. Homer, Mrs. L. Mansey, T. Morton, Mrs. A. Mudrochova, R. Sandilands, D. St. Jacques

Technical Operations Section

Head, H.B. Macdonald

Secretary – Miss L. Magnussen

Senior Assistant – D.J. Cooper

Diving Officer – J.T. Roe

Standards & Development – D.J. Williams

Special Projects – P.R. Youakim

Operations Officers – D.H. Hanington, D.J. Brooks

Technical Staff: L. Benner, T.J. Carew, H.K. Cho, F.J. deVree, H.F. Don, P.M. Healey, R.D. Hore, G. Koteles, M.R. Mawhinney, B.H. Moore, P. Seidenberg, S.J. Statham, M.R. Thompson, S.P. Withers

International Field Year for Great Lakes

Canadian Co-ordinator – J. MacDowall

Administration Section

Head, H. Lawson

Support Staff – J.L. Harris, D.G. Jefferson, Miss I. O'Connor, Mrs. E. Rae

CENTRAL REGION (Marine Sciences Branch)

A/Chief, Central Region – T.D.W. McCulloch

Secretary – Miss L. Ram

Regional Hydrographer – T.D.W. McCulloch
Asst. Regional Hydrographer – R.W. Sandilands

Hydrography

Asst. Regional Hydrographer – R.W. Sandilands

Hydrographers-in-Charge	Field Party – Survey Area
R. Courtnage	Rideau River & Thousand Islands
G. Goldsteen	C.C.I.W. Ground Control
C. Leadman	Lake-of-the-Woods
R. Marshall	Technical Records
J. O'Shea	Polar Continental Shelf Project
A. Rogers	Lake of two Mountains
E. Thompson	Navigational Ranges
G. Wade	Revisory Survey
B. Wright	Lower St. Lawrence River
F.L. DeGrasse	Navigational Systems

Hydrographic Staff

K. Barnes, R. Beri, R. Chapeskie, J.V. Crowley, M. Crutchlow, K. Daechsel, P. Dal Bianco, P. Davies, B. Eidsforth, J. Gervais, M. Grant, S. Greenner, K. Hipkin, J. Kean, R. Langford, R. Lasnier, G. Macdonald, R. Mahaffy, J. McCarthy, R. Moulton, D. Nesbitt, P. Pagé, D. Philpotts, H. Pulkinnen, R. Rehbein, P. Richards, R. Robitaille, W. Silvey, R. Treciokas, E. Waugh, J. Weller, A. Welmers, J. Wilson

Ships & Launches

Head – A. Quirk
Support Staff – Capt. D.R. Young, master of CSS LIMNOS; K.D. Robertson – Foreman (120 seasonal employees)

Development Group

Head – E. Brown
Technical Staff – E. Lewis, R. Tripe, N. Stuifbergen.

Electronics Section

Head – V.S. Bains

Technical Staff – D. Chambers, R. Desilets, J. Lanouette, M. Moore, A. Prud'Homme, D. Pyatt, W.W. Smith, B. Waldock

Administration Section

Admin. Officer – A.W. Appleby

Support Staff – Mrs. B. Dal Bianco, J. Dobson, Mrs. E. Gervais, E. Gibbons, Mrs. F. Haaka, Mrs. F. Hannay, Mrs. L. Mortimer, J. Rothwell, J.E. Parsons, Mrs. P. Taylor.

HYDRAULICS SUBDIVISION (Hydrologic Sciences Division, Inland Waters Branch)

Head, Dr. T.M. Dick Dr. L. Lau

Secretary – Mrs. L. Kay

WATER QUALITY DIVISION (Inland Waters Branch)

Analytical Chemistry Laboratories

Head, Dr. V.K. Chawla
Chemist, F.J. Philbert

Scientific and Technical Staff – H. Alkema, W.D. Blythe, O. El Kei, S. Meszaros, Y.M. Sheikh

Water Pollution Research Subdivision

Head, A.R. Townshend

Secretary – Miss V. Knox

Dr. B.P. LeClair, A.D. Stephenson

RESOURCES RESEARCH CENTRE (Policy Research & Coordination Branch)

Head, Dr. T.R. Lee

Secretary – Mrs. R. Riggs

G. Bangay, Miss M.R. Sinclair, J.N. Thomson

PUBLIC HEALTH ENGINEERING DIVISION (NH&W)

Liaison Officers – Dr. C.P. Fisher, Ottawa; B.J. Dutka, Kingston.

Support Staff – P. Collins, A. Jurkovic, A. Menon, H. van Otterloo

ENVIRONMENTAL QUALITY CO-ORDINATION UNIT

Head, Dr. A.R. LeFeuvre

Secretary – Mrs. H. Hetherington

ENGINEERING & SCIENTIFIC SUPPORT DIVISION

Chief, A.S. Atkinson

Secretary – Mrs. D. Magee

Engineering Systems Section

Head, G.A. Jones

Electronics Unit Head – A.S. Eatock

Electronics Engineers – K.N. Birch (Educational Leave), K.R. Peal, J. Valdmanis

Technologists – J.A. Diaz, D. Fekyt, J.G.M. Laroque, K. Mollon, M. Pedrosa, A. Tyler

Mechanical Unit Head – A.E. Pashley

Mechanical Engineers – B.P. Brady, P.M. Ward-Whate

Technologists – R. Boucher, J.D. Heidt, H.A. Savile

Machinists – R.V. Chumley, K. Kalter, D.H. Whyte

Drafting Office – W. Finn, A.P. Gris, Miss S. Longstaffe

Computer & Data Services Section

Head, D.M. Francis

Computer Applications Unit – H.S. Weiler, O.I.C.

Programmers – B. Hanson, Miss B. Pyde

Computer Systems Unit – C. Pulley, O.I.C.

Support Staff – Mrs. M. Kinder, Mrs. P.A. Moody

Data Unit – W. Nagel, O.I.C.

Support Staff – J. Byron, K. Schopf, G. Smith

Library

Librarian, Mrs. E.A.C. Fosdick

Support Staff – Miss A.E. Boerchers, Mrs. C.E. Davidson

Radiochemistry Laboratory

Dr. R.W. Durham (A.E.C.L.)

PUBLIC RELATIONS & INFORMATION SERVICES

Head, A.R. Kirby

Secretary – Mrs. R. Mikoda

Appendix B

Publications and Presentations

PUBLISHED PAPERS

**Blanton, J.O.,* and C.D. Jennings. 1970. Determination of fresh-water discharge for an Oregon estuary. Northwest Science, 44(3): 170-175, 1970.

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Rust, B.R. and *J.P. Coakley.* 1970. Physico-chemical characteristics and postglacial desalination of Stanwell-Fletcher Lake, Arctic Canada. Canadian Journal of Earth Sciences, 7(3): 900-911, June 1970.

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**LeClair, B.P.* and A.E. Hamielec. 1970. Viscous flow through particle assemblages at intermediate Reynolds numbers; steady-state solutions for flow through assemblages of cylinders. I&EC Fundamentals 9(4): 608-613, Nov. 1970.

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*Pruppacher, H.R., *B.P. LeClair,* and A.E. Hamielec. 1970. Some relations between drag and flow pattern of viscous flow past a sphere and a cylinder at low and intermediate Reynolds number. J. Fluid Mech. 44(4): 781-90, Dec. 1970.

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of the Royal Meteorological Society, 96: 149-151, 1970.

**Munawar, M.* 1970. Limnological studies on freshwater ponds of Hyderabad – India. Part I. The biotope. Hydrobiologica 35 (1): 127-162, 1970.

**Munawar, M.* 1970. Limnological studies on freshwater ponds of Hyderabad – India. Part II. The biocenose. Distribution of unicellular and colonial phytoplankton in polluted and unpolluted environments. Hydrobiologica 36 (1): 105-218, 1970.

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Prince, A.T. and *J.P. Bruce.* 1970. The Canada Centre for Inland Waters, An Approach to Research Co-ordination. Paper prepared for an OECD meeting, Hamilton, July 1970.

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Elder, F.C. and P.J. Denison. 1970. Thermal inputs to the Great Lakes, 1968-2000. Presented at the American Chemical Society, 160th National Meeting, Water, Air & Waste Chemistry Section, September 18, 1970.

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Gray, C.B. and *A.L.W. Kemp.* 1970. A quantitative method for the determination of chlorin pigments in Great Lakes sediments. Proc. 13th Conference Great Lakes Research, International Association for Great Lakes Research. (in press).

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Nauwerck, A. 1970. Zooplankton and the eutrophication of lakes. Presented at the Annual Meeting of the

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Sly, P.G. 1970. The responsibility of government, industry and university in marine science. Presented at the Central Canada University Geological Congress, Kingston, October 1970 (in press).

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COLLECTED REPRINTS

Canada Centre for Inland Waters, COLLECTED REPRINTS, Vol. 2 for inter-Library exchange program.

Appendix C

Staff Participation in Committees and Associations

Advisory Board to State University of New York's Sea Grant Programs (Lake Ontario) – J.P. Bruce

American Meteorological Society, Committee on Water Resources – Dr. R.K. Lane

American Water Resources Association, Board of Directors – J.P. Bruce

Canadian Aeronautics and Space Institute, Founder member of the Hydronautics Section – J. MacDowall

Committee on Water Resource Applications, Program Planning Office for Interdepartmental Committee on Resources Satellites and Airborne Remote Sensing – Dr. R.K. Lane

Great Lakes Working Group, Canadian Committee on Oceanography – Dr. R.A. Vollenweider

Instrumentation Advisory Committee, Mohawk College – G.A. Jones

Interdepartmental Committee on Nutrients – Dr. A.R. LeFeuvre, Dr. T.R. Lee

Interdepartmental Working Group on Contingency Plans – Dr. A.R. LeFeuvre

Interdepartmental Technical Working Group on Contingency Plans – Ch., Dr. A.R. LeFeuvre

International Association for Great Lakes Research (IAGLR).

President – J.P. Bruce

Editorial Board, Proceedings of IAGLR Conferences – Dr. R.K. Lane, Dr. P.G. Sly

14th Conference: Co-Chairman Program Committee – F.C. Elder; Co-Chairman Local Arrangements – G.A. Jones; Co-Chairman Public Relations Sub-Committee – A.R. Kirby

International Field Year for the Great Lakes, Canadian Co-ordinator – J. MacDowall.

Steering Committee – J.P. Bruce

Chemical & Biological Programs – Dr. R.A. Vollenweider

Energy Budget – Dr. R.K. Lane, F.M. Boyce

Lake Meteorology – F.C. Elder

Terrestrial Water Balance – Dr. R.K. Lane

Water Movement – Dr. H.S. Weiler

24th International Geological Congress – 1972, Montreal – Excursion Planning – Dr. P.G. Sly, Dr. C.F.M. Lewis

International Great Lakes Study Group – Dr. R.A. Vollenweider

National Research Council Associate Committee on Avionics – J. MacDowall

National Research Council, Committee on Environmental Criteria, Sub-committee on Water Quality Criteria – Dr. R.A. Vollenweider

National Research Council Sub-committee on Hydrology – Dr. R.K. Lane

North American Working Group on Manganese – Dr. R.L. Thomas

Organization for Economic Co-operation & Development – Working Group on Eutrophication, Water Management Research Group – J.P. Bruce, R.A. Vollenweider

U.S. – Canada Working Group on Great Lakes Pollution

Sub-Group on Water Quality Criteria & Programs – Dr. R.A. Vollenweider

Sub-Group on Contingency Plans – Dr. A.R. LeFeuvre

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Sub-Group on Co-ordination of Action to Meet Special Situations – Dr. T.R. Lee

World Meteorological Organization – Working Group on Hydrological Applications of World Weather Watch – J.P. Bruce

Appendix D

Advisory Committee to the Canada Centre for Inland Waters, and Working Groups

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Appendix E

Contracts 1970

1. Research study on a process modification for partial nitrogen and phosphorus removal to be carried out at an activated sludge plant at Penetanguishene, Ontario. (University of Toronto – $18,400).

2. Study to describe the nature and extent of chemical-physical-biological changes which occur in the lower Grand River and estuarial waters and their modification of eutrophifying effects of the discharge on Lake Erie. (University of Guelph – $14,400).

3. Carry out the analysis of error significance in energy flux computations from meteorological measurements over water. (Dr. R.G. Stevens, Dartmouth, N.S. – $6,100).

4. The development of a rapid analytical method for identifying mercury forms based on the differential release of mercury from its associated components in identifiable form at discrete temperatures and the volatilized mercury analyzed by a patented mercury spectrometer. (Barringer Research Ltd., $16,700).

5. Extension of a contract to continue research on a project involving the geological studies of the nearshore zone of Lake Superior from Wawa, north along the coast to the position approximately opposite Slate Island. (Lakehead University – $14,000).

6. Final pre-publication editing and quality review of all limnological data collected by the Great Lakes Institute, University of Toronto, during 1964. (Great Lakes Institute, University of Toronto – $3,800).

7. Contract to specify and advise on an oil spill research program and to assist in the preparation of a field manual on oil spill countermeasures (A.P. Frame Limited – $5,000).

8. Continuation of studies on the coastal jet phenomenon in an area to the west of Lake Ontario, off Oshawa. (University of Waterloo – $35,000).

9. Carry out a preliminary program of short-term measurements of aspects of solar radiation. (McMaster University – $5,000).

10. To provide limnological data from six monitor cruises on Lakes Huron, Superior and Georgian Bay. (Great Lakes Institute, University of Toronto – $25,000).

11. Preparation of scientific reports on the physical and chemical aspects of the environment of Lake Ontario and Lake Superior. (Great Lakes Institute, University of Toronto – $27,000).

12. Undertake a joint experiment with the Centre in connection with measurements and analyses of micro-scale thermal structure in Lake Ontario. (University of British Columbia – $1,000).

13. Development of a realistic mathematical model of the winter circulation of Lake Ontario. (University of Connecticut – $10,000).

14. Contract for design of data collection systems, the development and operation of programs for analysis of data from intensive area studies, and the preparation of historical summaries of chemical monitor cruise data for the Great Lakes (McMaster University – $32,100).

15. Special investigation, modification and study of recording water current meters (Canadian General Electric Co. Ltd. – $15,000).

16. Digitization of all bathythermograph traces taken on all of the synoptic surveys of the Great Lakes Institute on Lakes Huron and Superior and Georgian Bay from 1960 to 1970 inclusive. (University of Toronto – $3,500).

17. Documentation, processing and interpretation of previously collected limnological data consisting of spatial and temporal distributions of temperature in the Great Lakes. (University of Waterloo – $14,100).

18. Repair, maintenance and servicing of Plessey and Geodyne water current meters. (Canadian General Electric Ltd., – $44,600).

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