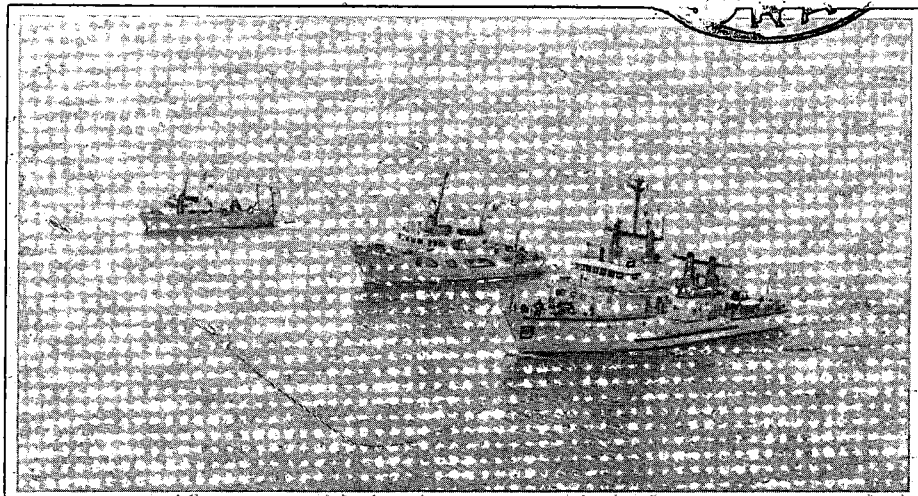
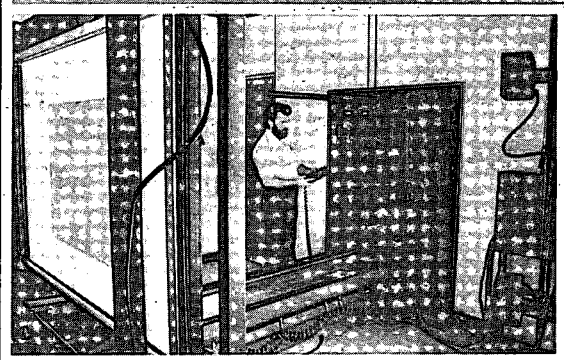
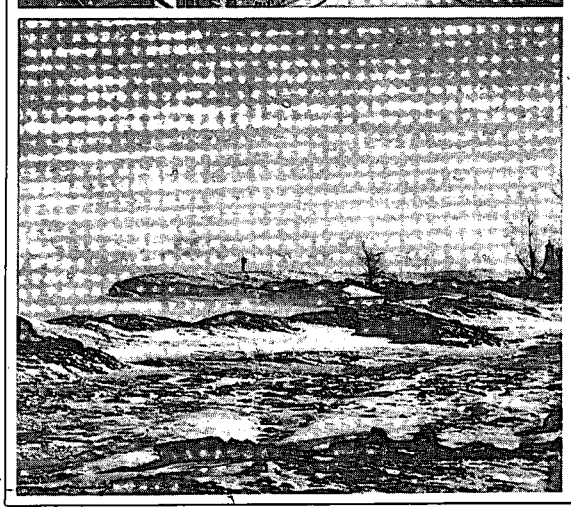
1979 ANNUAL REPORT







Canada

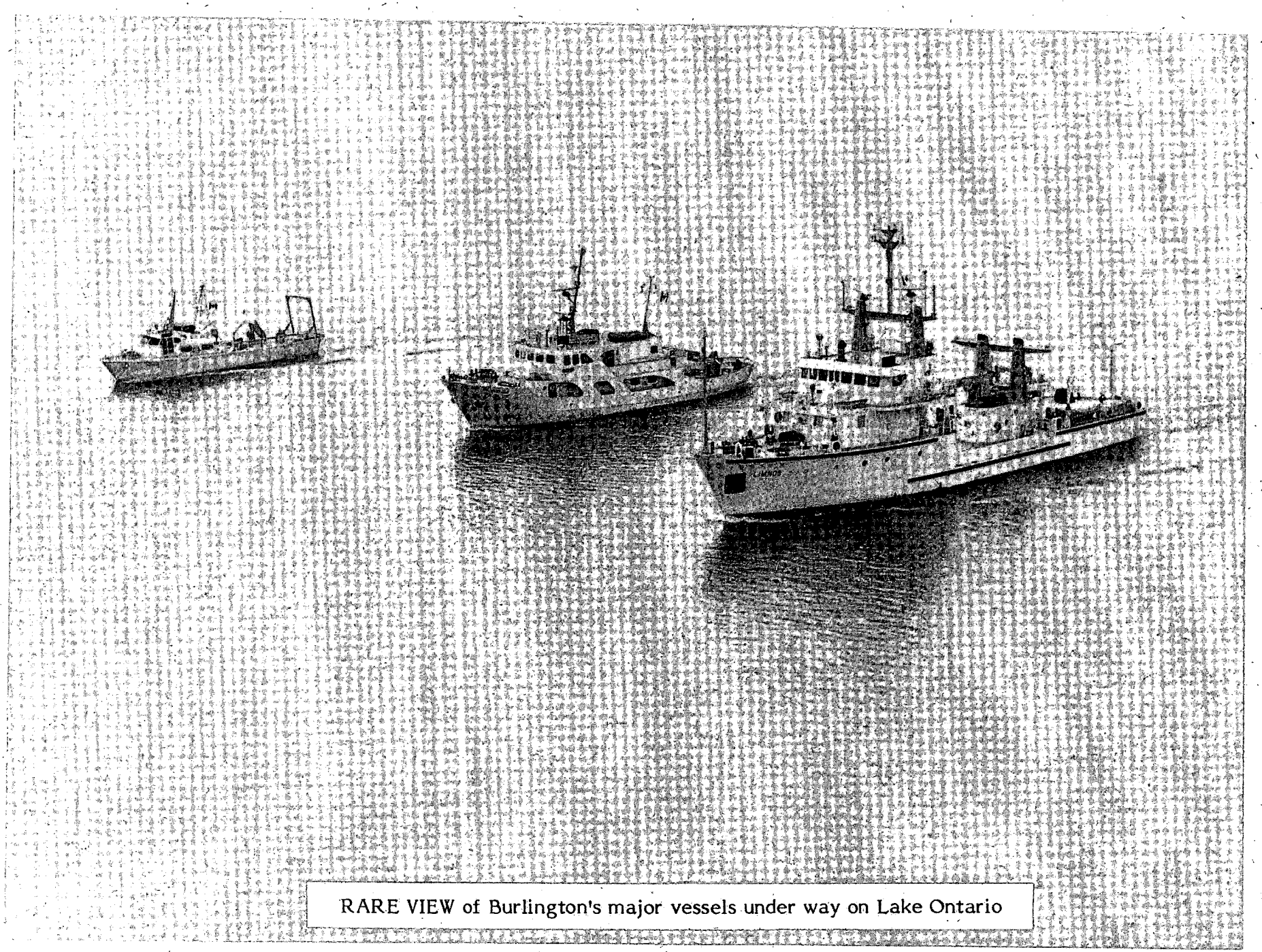
Ocean and Aquatic Sciences
Central Region
Fisheries and Oceans Canada
Burlington, Ontario

1979 ANNUAL REPORT

CENTRAL REGION

OCEAN AND AQUATIC SCIENCES

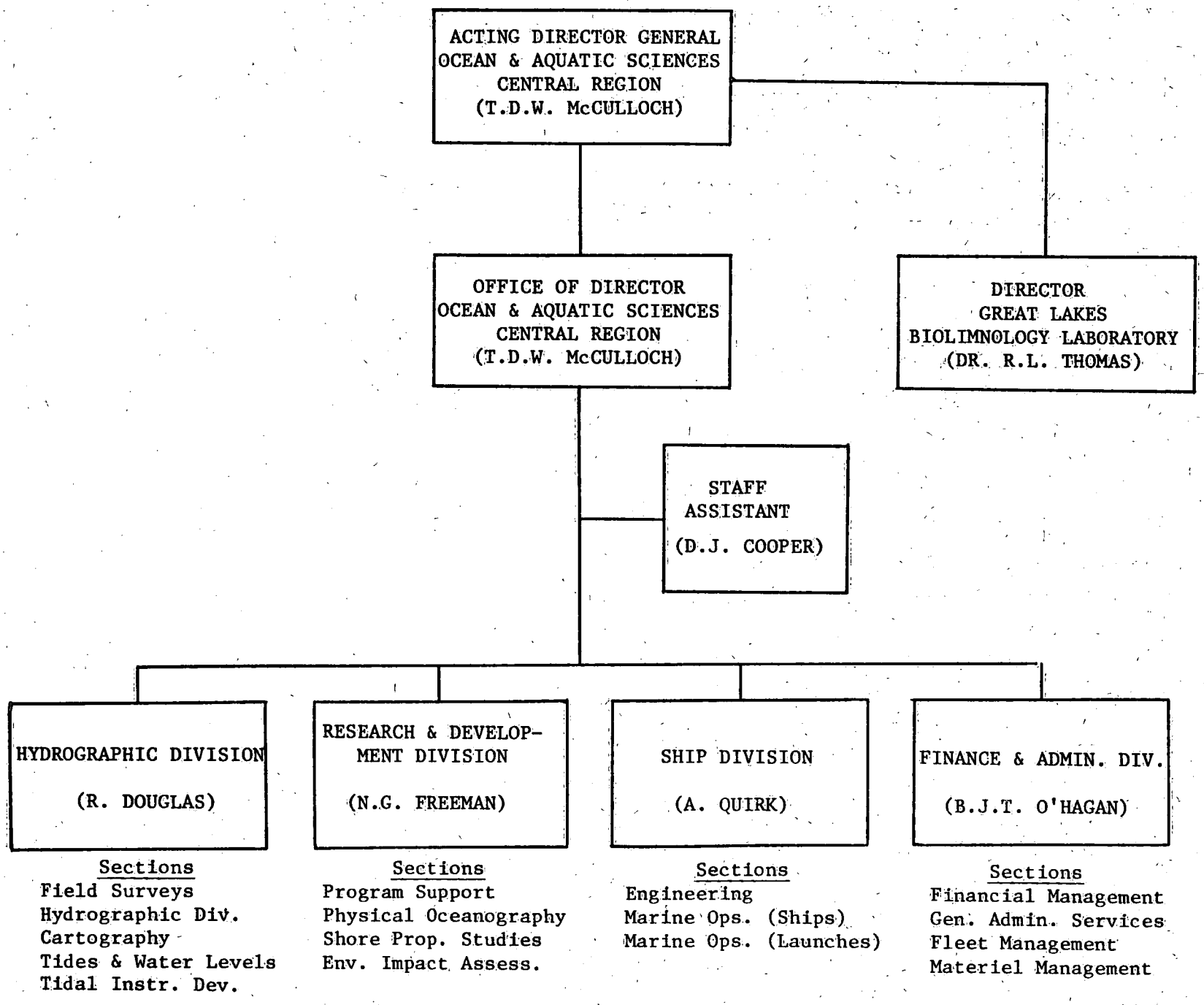
DEPARTMENT OF FISHERIES AND OCEANS



RARE VIEW of Burlington's major vessels under way on Lake Ontario

Table of Contents

	Page
ORGANIZATION CHART	iv
OVERVIEW	1
HIGHLIGHTS	2
IN THE PUBLIC INTEREST	4
HYDROGRAPHIC DIVISION	7
Introduction	7
Field Surveys - Review	9
Hydrographic Data Centre	9
Marine Information Centre	11
Chart Production	11
Hydrographic Development	12
Tides, Currents and Water Levels	13
Hydrographic Arctic Research Project (HARP)	15
Plans for 1980	15
RESEARCH AND DEVELOPMENT DIVISION	17
Introduction	17
Physical Oceanography	17
Biological Oceanography	21
Shore Properties Studies	21
Environmental Impact Assessment	22
Program Support	23
GREAT LAKES BIOLIMNOLOGY LABORATORY	25
Introduction	25
Ecosystem Studies	25
Environmental Toxicology	26
Surveillance	27
SHIP DIVISION	30
Operations	30
Hydrographic Surveys	30
Great Lakes Biolimnology Laboratory	32
Research and Development Surveys	32
Local Launches	33
Search and Rescue	33
Boatshop	33
REGIONAL MANAGEMENT SERVICE	35
Regional Management in Review	36
PRESENTATIONS AND PUBLICATIONS	37
Hydrographic Division	37
Research and Development Division	37
Great Lakes Biolimnology Laboratory	39
CENTRAL REGION STAFF LIST	43


ACTING DIRECTOR GENERAL
OCEAN & AQUATIC SCIENCES
CENTRAL REGION
(T.D.W. McCULLOCH)
OFFICE OF DIRECTOR
OCEAN & AQUATIC SCIENCES
CENTRAL REGION
(T.D.W. McCULLOCH)
DIRECTOR
GREAT LAKES
BIOLIMNOLOGY LABORATORY
(DR. R.L. THOMAS)
STAFF
ASSISTANT
(D.J. COOPER)
HYDROGRAPHIC DIVISION
(R. DOUGLAS)
RESEARCH & DEVELOP-
MENT DIVISION
(N.G. FREEMAN)
SHIP DIVISION
(A. QUIRK)
FINANCE & ADMIN. DIV.
(B.J.T. O'HAGAN)
Sections
Field Surveys
Hydrographic Div.
Cartography
Tides & Water Levels
Tidal Instr. Dev.
Sections
Program Support
Physical Oceanography
Shore Prop. Studies
Env. Impact Assess.
Sections
Engineering
Marine Ops. (Ships)
Marine Ops. (Launches)
Sections
Financial Management
Gen. Admin. Services
Fleet Management
Materiel Management

OVERVIEW

The Central Region of Ocean and Aquatic Sciences has its headquarters at the Canada Centre for Inland Waters, Burlington, Ontario. The operating area of the Region stretches beyond the Great Lakes to the Saskatchewan-Manitoba border in the west, the Upper St. Lawrence River in the east, and James Bay/Hudson Bay and the Queen Elizabeth Islands in the north.

The Region reports operationally through the Director to the Director-General, Ocean and Aquatic Sciences for Ontario and functionally for the development of national policy to the Assistant Deputy Minister, OAS. It consists of four divisions: Hydrographic, Research and Development (Oceanographic), Ships, and Administration, with an allocated man-year total of around 200 and a budget in excess of $8.3M.

The Hydrographic Division is the largest group and provides the central core of strength around which the Region is constructed. The R&D Division is largely oceanographic in content, with additional expertise in matters affecting the coastal zone. The Ships Division provides both ships and launches required by OAS, other elements of the Department, outside agencies such as universities and last, but certainly not least, meets the varied and sometimes complex requirements of the National Water Research Institute, the major occupant of CCIW.

The Great Lakes Biolimnology Laboratory (GLBL) based at CCIW continues to be associated with OAS and once again this is reflected by the inclusion of their Annual Report within this volume. In addition to its research activities on the relationships between water quality and aquatic resources in the Great Lakes, GLBL provides scientific and technical expertise to several inter-agency and inter-departmental committees such as the Surveillance Subcommittee of the International Joint Commission, Working Groups associated with EARP (Environmental Assessment and Review Process), Great Lakes Fishery Commission, etc.

This was the second year of the Planning Review Evaluation (PRE) and coincidentally also the second year of an administrative link between GLBL and OAS. The linkage was additionally strengthened by OAS membership on the Canada/Ontario Water Act Review Board and the Great Lakes Water Quality Agreement Working Group. The PRE exercise was completed by the end of the year, including the proposed targets for the Program Forecast Years to 1981-82.

At mid-year, a Fisheries and Oceans personnel organization was formed in Central Region, administratively responsible to the Director-General. Welcome aboard.

The Arctic program was influenced to a large extent by factors beyond our control. The decision by MOT to transfer CCGS NARWHAL to the west coast for an indefinite period caused a cancellation of the hydrographic offshore Hudson Bay Program; budget cuts meant the forfeiture of the charter vessel MV PETREL V for the inshore Hudson Bay surveys and an end to our winter cooperative program in Hudson Bay with Earth Physics Branch EMR.

Despite this, Central Region's activities continued at a high level with field parties enjoying a successful year. The offshore hydrographic survey of Lake Superior was completed and ongoing surveys on Lakes Nipissing, Erie, Ontario and the St. Lawrence River made excellent progress. Most of the hydrographic and all of the oceanographic programs from the lower St. Lawrence have now been transferred from the region to the responsibility of the Quebec Region.

Physical oceanographic research in Hudson and James Bays continued with studies being carried out on the changes to the marine and estuarine environments caused by runoff modifications associated with hydroelectric developments. Towards the end of the year our ongoing involvement in biological studies in the Hudson/James Bay region were regulated by the secondment of a zooplankton biologist from GLBL. He will continue to provide contract liaison with the University of Guelph and will assist in developing biological programs for the sub- and high-Arctic.

Studies conducted by GLBL were expanded during 1979 to incorporate increased activity due to the signing of the revised Great Lakes Water Quality Agreement between Canada and the United States. The program changed in order to accommodate increased efforts in contaminants surveillance in Great Lakes biota and in research on the effects of contaminants.

Additionally, in response to the concerns over the effects of atmospheric pollutants, substantial diversion of effort was made to start new initiatives in the development of a program to address some of the fisheries concerns relating to lake acidification and contaminants derived from the atmosphere.

All studies are incorporated into three interrelated programs, namely Ecosystem Studies, Environmental Toxicology, and Surveillance. A general overview of the

studies undertaken in these programs during 1979 is described under their respective headings in this volume. Further activities and studies expected in the future are:

- A resumption of the cooperative program with Earth Physics Branch EMR as part of the Polar Continental Shelf Program in the M'Clintock Channel.
- In the absence of either a charter vessel or NARWHAL, hydrographic surveys will be confined to the southerly areas of the region.
- A major physical oceanographic program in the Sverdrup Basin of the Arctic Archipelago in the spring of 1981 to examine the circulation and mixing of water masses through this region as they relate to pollutant transport. Projected plans are to carry out a physical and biological oceanographic program in the summer of 1982 in Hudson Bay to measure the effects of the post-project La Grande Complex on the marine environment.
- The Region is now entering the initial phase of design input for a new Resource-Survey vessel with delivery projected for 1983-84.
- The interim position of GLBL makes their direction in the future uncertain; however, a significant initiative in 1979 was the development of another GLBL satellite laboratory in the Owen Sound region. This lab will develop applied and research studies in Lake Huron and Georgian Bay in collaboration with the Ontario Ministry of Natural Resources. It is anticipated that this facility will be operational in the spring of 1980.

HIGHLIGHTS

The year 1979 followed a rather nondescript but successful course for the Region.

The Department of Fisheries and Oceans was established in April, creating some new mental barriers at CCIW, none of which formed any lasting breach in bi-departmental spirit or action.

Prior to the split of departments, the Director visited the Far East to attend a meeting of the Commonwealth Association of Surveyors and Land Economists (CASLE) in Hong Kong and give a paper on the Survey Requirements for the 1980's. He also visited surveying and hydrographic establishments in Malaysia, Singapore and Japan.

As an event, the CCIW Open House could not have been more appropriately timed. Shortly after the formation of DFO, the Centre had its first well organized Open House which was tremendously successful. First, the public came, was enthralled, bemused and excited by what it saw and heard. Second, the staff of the Centre as a whole had a great uplift and boost in morale by their participation in welcoming over 23,000 visitors, including 4,000 students from 80 schools. The dockside and ship exhibits were a great attraction and most popular of all to the visitors (see following - In the Public Interest).

In May the Region was host to a party of Mainland Chinese oceanographers and engineers on a cross-Canada tour. In addition to being Federal Election Day, the visit was a memorable one for all who took part.

Preparations for the implementation of the 1979-80 Search and Rescue (SAR) plan began in early January and despite the inevitable tribulations associated with the birth and weaning of an entirely new program, the season was a great success in that virtually all objectives were achieved, commitments met and a significant contribution made to the national SAR response capability. One notable incident was the CARTIERCLIFFE HALL disaster in which BAYFIELD helped to extinguish the fire on board while standing by to receive survivors. A commendation was received for this effort from Rear-Admiral Fugaro, U.S. Commander of the 9th Coast Guard District.

The Region was heavily committed to providing many forms of input for the International Hydrographic Technical Conference (IHTC) at Ottawa in mid-May due to the involvement of staff in the sponsoring bodies: the Canadian Hydrographic Service (CHS), the Canadian Institute of Surveying (CIS), the Canadian Hydrographers Association (CHA) and the International Federation of Surveyors (FIG). CSS ADVENT was locked into the Rideau Canal and was berthed alongside the Conference Centre for inspection by the delegates.

At mid-year the Director represented Canada at the FIG Permanent Committee Meeting in BRNO, Czechoslovakia. In addition, as Chairman of Commission Four, he presented the Commission annual report to the Permanent Committee, advising them of the May 1979 International Hydrographic Technical Conference held in Ottawa and of the Commission's plans for the 1981 FIG Congress to be held in Montreux, Switzerland. Later he visited with R. Steel, Secretary-General of CASLE, in London, and further planned the CASLE General Assembly scheduled for 1981 in Canada. Meetings were also held with Rear-Admiral Haslam, Hydrographer of the Royal Navy, on preliminary plans for the 2nd IHTC tentatively to be held in Brighton, England in 1983, and on general Commission Four matters. The North Sea was visited briefly to ensure continued up-to-date knowledge of hydrographic survey-related activities in that area.

We were honoured in August by the visit of Mr. G. N. Ewing, Assistant Deputy Minister of Ocean and Aqua-

Chinese oceanographers touring OAS facilities (courtesy George Tansley, Burlington Post)

tic Sciences, who met with the Acting Director-General and the senior staff of Central Region.

Earl Brown, Assistant Regional Hydrographer, was selected to provide the regional input for Organizational Study of the Ontario Region (Griggs Study). Between interviewing management in the Region, writing results, and liaison with the study group, his task was formidable.

The Director completed a Discussion Paper entitled, "An Evaluation of Technology Transfer Process in Ocean and Aquatic Sciences," for the Assistant Deputy Minister. The objective of the paper was to develop a viable technology transfer program in DFO/OAS in support of the government's plan to develop ocean industry within the maritime regions of Canada. The fostering of this industry domestically will ensure eventual export of that industry's products and expertise to foreign markets.

The Regional Chart Production Unit is now a viable entity and up to full strength with the completion of the decentralization of cartographers from Ottawa.

Dr. J. R. Vallentyne (Senior Scientist, Fisheries and Oceans) was transferred from the Ontario Region Headquarters' staff to GLBL on April 1, 1979. He has been engaged in making presentations to various groups on the Great Lakes Basin as an ecosystem. His proposal for a conference on 'Global Resources' has been accepted and is being organized by Dr. Nicholas Polunin as the Third International Conference on the Environmental Future (1981).

For the second year, after completing summer surveys in Lake Superior, the NOAA vessel PEIRCE stopped for a courtesy call at Burlington, arriving on October 10 and departing for Norfolk, Virginia, on October 15. During her stay, the commanding officer arranged for an Open House for CCIW personnel. On Friday, October 12, Admiral Munson, Commander Dale North and his officers visited CSS BAYFIELD where they were hosted by the Region. Meetings involving Charting Advisors and FIG Working Group 415 were held.

For more than a year we have had the pleasure of having Dr. Rich Thomas and his team from GLBL aboard. We still await the final decision on their destiny but the association continues to be well worthwhile for all of us.

Once again the federal government exhibit at the Toronto International Boat Show was managed from the Region. This involved the Departments of Fisheries and Oceans, Environment, and Transport in an enlarged exhibit area.

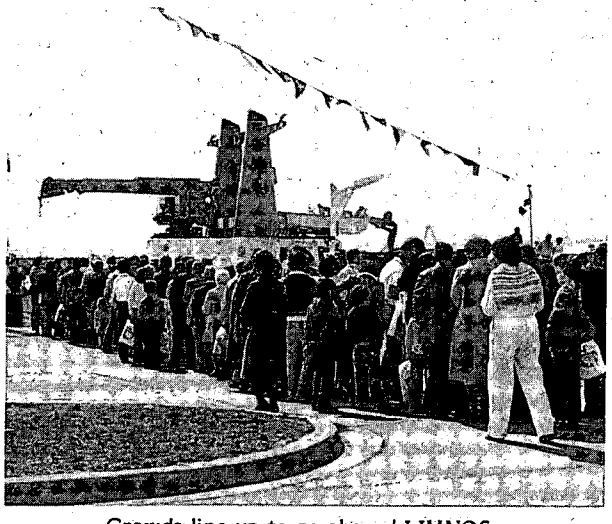
Finally I would like once more to give a "thank you" to Finance and Administration for keeping the Region on an even keel during the expected and unexpected changes of course through the year, to the secretaries for their help in keeping our heads above water, and to Derek Cooper, my Staff Assistant, for compiling and editing this report.

T. D. W. McCulloch

IN THE PUBLIC INTEREST

The growing realization that public understanding of government programs, projects and people is essential if there is to be public support, has been the motivation for OAS to take a leading role in the development of public awareness about Canada Centre for Inland Waters and Great Lakes activities.

A new plateau in the ten-year history of the Centre was achieved as a result of the successful efforts made by almost everyone in the organization during the three day Open House in April. As every sailor knows, an opportunity to go aboard a ship is a powerful draw for the public.



Crowds line up to go aboard LIMNOS

More than 23,000 citizens, including some 4,000 high school students and their teachers from 80 schools in five counties toured the Centre. CSS LIMNOS, BAYFIELD and ADVENT were full to the gunwhales with eager visitors who, at peak periods during the three days of fine weather, were lined up across the dock and into the parking area.

Open House was characterized by the enthusiasm of staff members at every level in volunteering their services to explain their work and how it benefits the general public.

The fish display and wet lab tours of GLBL were prime traffic stoppers and were complemented by the

imaginative efforts of the people in Shore Properties and Oceanography.

Professionally-conducted surveys of the visiting public demonstrated that Open House achieved its objectives and exceeded expectations by a wide margin. A slide talk about the planning and execution of Open House has proven of value to Fisheries and Oceans headquarters and regional information officers in planning their own events.

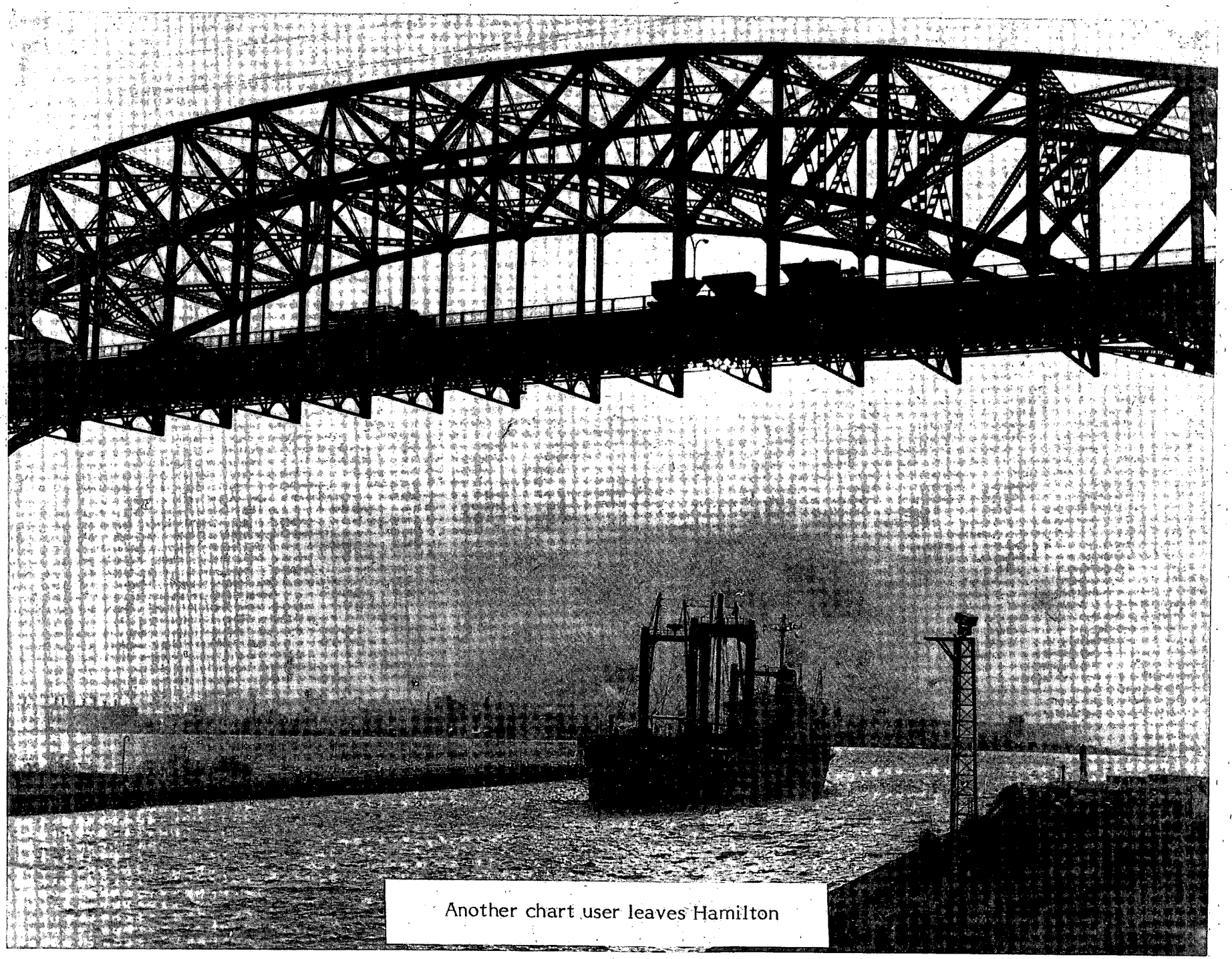
Central Region continued its initiative in improving public awareness throughout the year, generating substantial attention in a wide range of local, regional and national newspapers, magazines, radio and television. Publicity activity aimed at encouraging use of charts by small craft owners was particularly successful. Canadian Hydrographic Service personnel participated in radio and television interviews on a frequent basis. Officers in charge of field parties found themselves in demand for newspaper interviews and talks.

Such activities were encouraged by providing training and practice facilities, utilizing in-house television equipment when it was not in use in the field, along with professional advice.

Material for future slide shows was accumulated by providing field parties with film, thus overcoming the cost constraints that prohibit sending photographers to widely scattered locations. Considerable talent was uncovered in this manner. In addition, the best of the slides was useful in generating television coverage of the work.

It is worth emphasizing that the successes in public relations have been most favourably influenced by the enthusiastic cooperation of managers and staff in generating and taking advantage of opportunities presented.

Support for public awareness program activities is being continued in 1980.

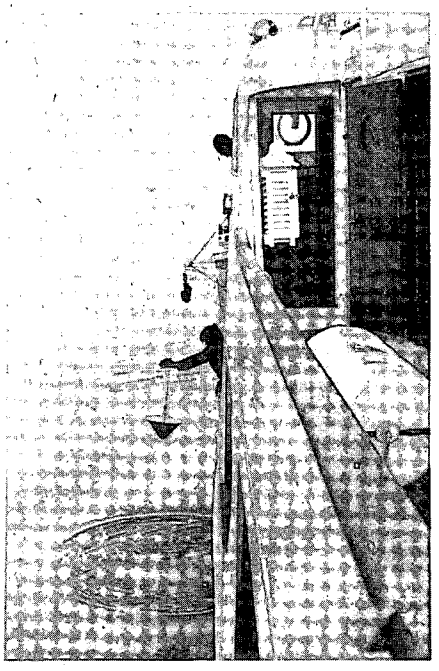


Another chart user leaves Hamilton

HYDROGRAPHIC DIVISION

Introduction

The hydrographic program in 1979 was influenced to a large extent by factors beyond our control. The decision by MOT to transfer C.C.G.S. NARWHAL to the west coast for an indefinite period caused a cancellation of our offshore Hudson Bay Program; budget cuts meant no charter ship for our inshore Hudson Bay surveys and an end to our winter co-operative program in Hudson Bay with Earth Physics Branch.



"Cone Check" - C.S.S. BAYFIELD - Lake Superior

Despite this, Central Region's activities continued at a high level and our field parties enjoyed a successful year. The offshore survey of Lake Superior was completed and on-going surveys in Lakes Nipissing, Erie, Ontario and the St. Lawrence River made excellent progress, despite floods, strong winds and budgetary restraints. In the spring we took part in a highly successful three-day open house at the Canada Centre for Inland Waters. The "Hydrographic Story" as depicted in a series of film shows, posters, hands-on demonstrations, etc., was well received by the more than 23,000 people who attended.

Regional CHS staff participated in the activities of the Hydrographic Technical Conference in Ottawa and were heavily involved with planning and instructing at the associated Geometrics Seminar at Humber College.

During the year, the Region hosted several important meetings including the National Appraisal Board, the Great Lakes Charting Advisers, the National Planning and Priorities Committee, and the joint DFO-EMR Guiding Committee on Offshore Surveys.

Mr. E. Brown took part in the GRIGGS study of the Departmental Mandate, Objectives and Organization within Ontario Region of DFO.

R. Tripe, Acting Head of Development, and D. Knudsen, Head of the Tidal Instrumentation Section, left the Region to take up other positions. Three staff continued their studies through the University Training Plan (U.T.P.).

The Tidal Section carried out a current measurement program in the St. Lawrence River to supply necessary chart information and successfully deployed a number of tide gauges in the high Arctic. The Hydrographic Arctic Research program continued. Preliminary trials of MARRS were carried out in Bedford Basin.

A noteworthy event was the commercial production (by D. G. Instruments of Ottawa) of 15 "Navboxes" for the four regions of CHS. Additional units for other government and private companies are now being built.

Regional support was given to two aerial hydrography projects: in the North Channel of Lake Huron where stations were positioned and targetted, and on the St. Lawrence River where ground truth surveys and turbidity measurements were taken.

The Regional Chart Production Unit is now up to full strength with the completion of the decentralization of cartographers from Ottawa.

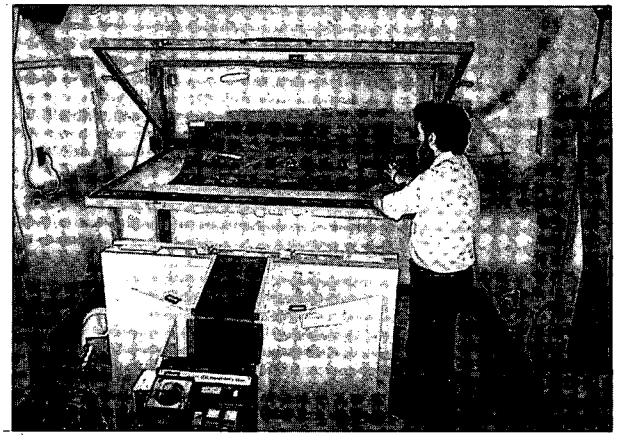
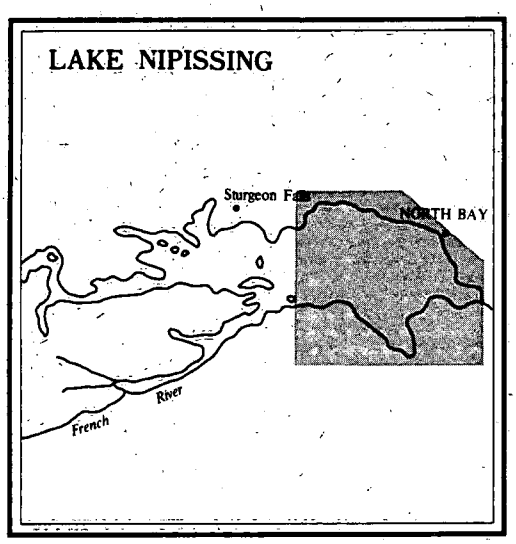
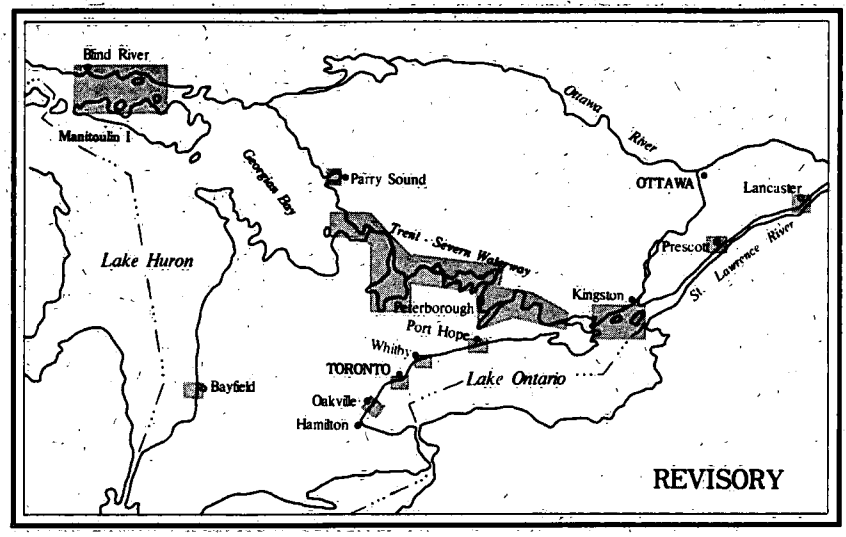


Chart Production Unit Vacuum Frame

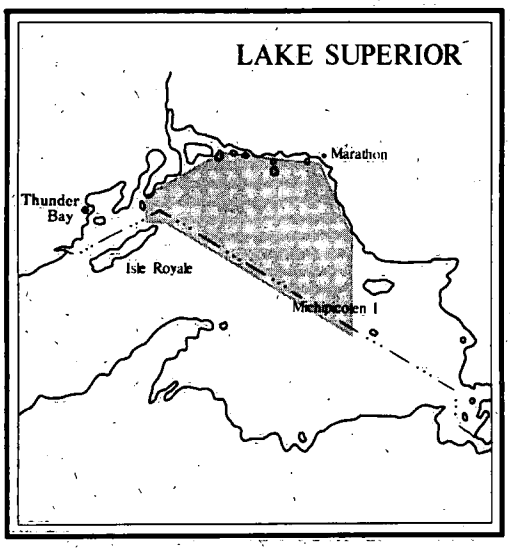
The acquisition of a process camera has added the final dimension to Central Region's chart production capability. We are now ready to undertake any reprographic assignment in-house.

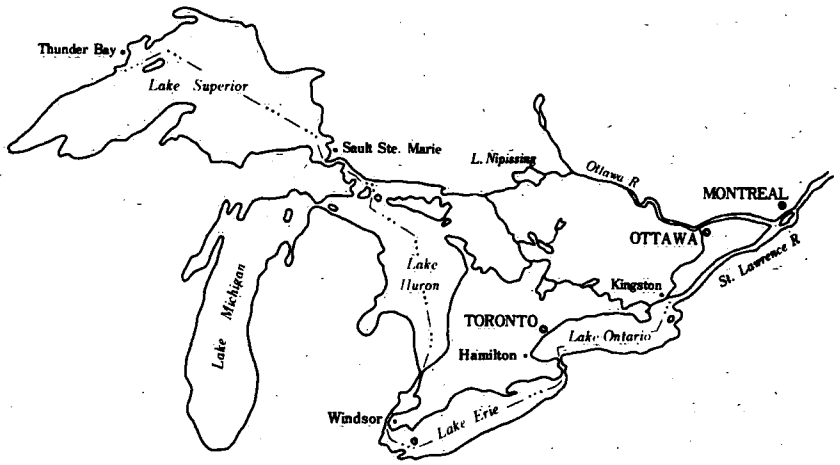


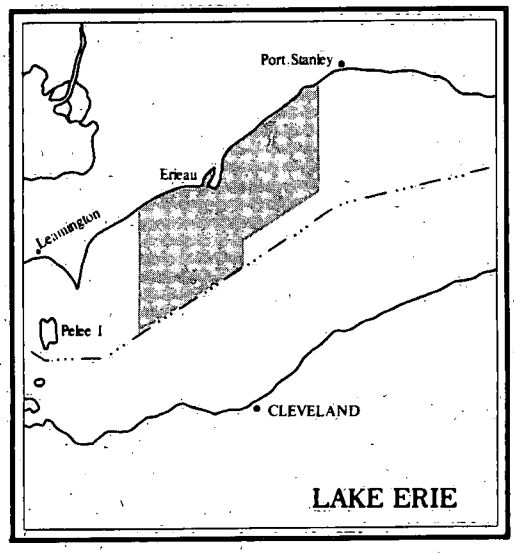


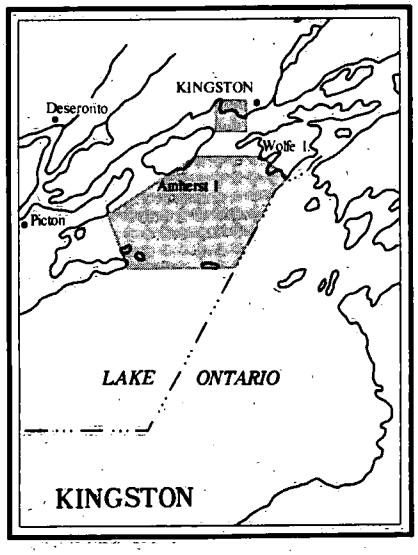
CENTRAL REGION
1979
HYDROGRAPHIC SURVEY PROGRAM
(Eastern and Southern Areas)

Area Surveyed









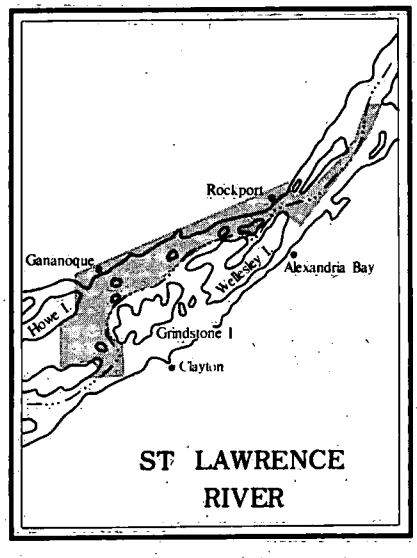


Figure 1

Field Surveys - Review

The areas surveyed by Central Region in 1979 are shown in Figures 1 and 2. Table 1 gives details of survey vessels, vehicles, positioning systems and processing techniques.

Table 1. Summary of 1979 Survey Activities

Survey area	Vessels	Positioning Systems	Field Data
PCSP	3 206B helicopters 1 tracked vehicle	MRS III with Navbox	Manual
L. Nipissing	2 Botved (21') 1 Monark 1 helicopter	MRS III with Navbox Hydrodist	Manual
L. Superior (offshore)	BAYFIELD (106')	Loran-C (Accufix) RPS	INDAPS
L. Erie (coastal)	2 Bertrams (25') 2 Hyrdos	MRS III with Navbox RPS	Manual
L. Ontario-Kingston (coastal)	NIMBUS (34') NAUTILUS (34')	MRS III Hydrodist	Manual Manual
St. Lawrence River	4 Botveds (21')	MRS III Hydrodist	Manual
Revisory	LFGB #2 (18') Boston Whaler	Sextant Hydrodist	Manual

Winter Survey

In association with the Polar Continental Shelf Project of EMR, a through-the-ice survey was carried out in Penny Strait, Queens Channel and Wellington Channel. Minirangers were used to position three helicopters and one tracked vehicle equipped with modified Edo echo sounders. Two of the helicopters used the newly-developed electrically driven ram while the third used the traditional oil method. The tracked vehicle used a hydraulically operated ram. Soundings were taken on 500 m, 1 km and 2 km grids, depending on the complexity of the bottom. A total of 12,787 spot soundings were obtained over an area of 27,500 square kilometres.

Summer Surveys

Scheduled surveys in the offshore and coastal waters of Hudson Bay had to be temporarily postponed because MOT transferred C.C.G.S. NARWHAL to the west coast. Budgetary restraint precluded the chartering of a suitable replacement vessel.

C.S.S. BAYFIELD, using Accufix Loran-C and INDAPS, successfully completed the offshore survey of Lake Superior. This will enable the existing charts to be updated. Of some interest is the confirmation of depth and position of Superior Shoal surveyed in 1930 by H. L. Leadman. The Accufix again worked exceptionally well for the entire season.

Despite ravaging spring floods, the survey of the eastern half of Lake Nipissing was completed. NavBox units interfaced to Miniranger provided straight-line navigation which resulted in much more productive survey time. A tellurometer MRD 1 (rented) was used successfully on this survey. Hydrographers were happy with the system and commented favourably on the signal stability at ranges of 40,000 m.

The Lake Erie survey continued eastward and completed the coastal area from Port Alma to Plum Point. NavBoxes were used with Minirangers for straight-line navigation. Because of problems incurred in previous years, interlining limnogeology survey lines was not carried out. The entire area was therefore resurveyed.

Personnel and resources originally scheduled for Hudson Bay were diverted to Lake Ontario and carried out a lower priority survey of the area between False Ducks Island and Simcoe Island. Two new 34-foot Nelson hull sounding launches were successfully used on this survey.

The St. Lawrence River survey was resumed after a delay of several years. Work began at Gananoque and continued eastward to Rockport, supported by the Aerial Hydrography project when aerial photography and laser profiles were obtained over a selected part of the River. We await the results with anticipation.

The mobile revisory unit had a busy year checking out queries on charts due for production in 1980. In addition, a cyclical survey was made of the Trent-Severn Waterway charts.

The exchange program with NOS was continued with one hydrographer from each organization participating. One rotational hydrographer was assigned to Chart Production and one compiler spent some time in the field.

An interesting survey was carried out near Prescott, Ontario, at the request of the Ministry of Transport. MOT is evaluating a Precise Radar Navigation System (PRANS) and the CHS was asked to position twelve PRANS reflector sites on both sides of the St. Lawrence River. In order to achieve the requested accuracy of ±2 cm, a K&E Laser Ranger V was borrowed from Geodetic Survey of Canada and a Wild T-3 was used to observe the horizontal angles. Some useful information on the limitations of our tellurometers was learned as a result of this operation.

In conjunction with Nautical Geodesy (HQ), hydrographers using BAYFIELD and RPS carried out Loran-C (east coast chain) calibrations in Lakes Erie and Ontario. After this, BAYFIELD headed for Lake Huron as support vessel for target laying and ground truth profile measurements for a photographic project in the North Channel.

Hydrographic Data Centre

The growth of HDC continued during 1979 although at a less hectic rate now that the Chart Production Unit is firmly settled in the Region. Some 979 documents, previously filed in Ottawa, were trans-

A group from Hydrography at the Marine Information Centre

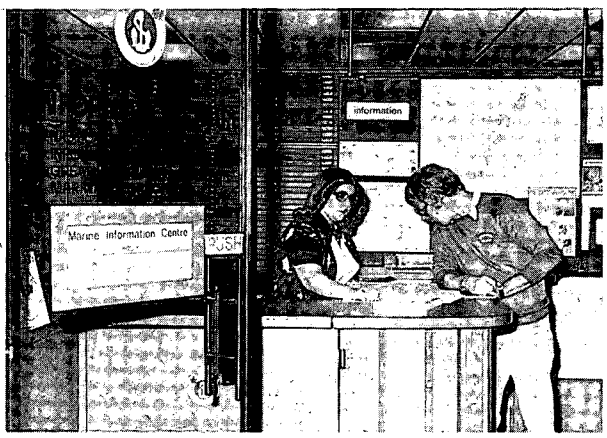
ferred to the Region. These included all closed chart correspondence files, 530 copies of U.S. and pre-1940 Canadian field sheets, and other chart production items concerning Central Region.

Hydrographers on short-term assignments to HDC assisted in making improvements to data handling systems. The storage of boatboards was reorganized to permit easier retrieval, the photo-slide collection was indexed and an improved method of recording library loans was introduced.

Direct access to the EMR computer in Ottawa via acoustic coupler and Decwriter has simplified retrieval of horizontal control information. Latest adjusted positions and existing control in any area may now be quickly obtained. Some modification of horizontal control records in HDC was necessary to accommodate the data bank.

Marine Information Centre

As a result of publicity received during the 'Open House' in April, local sales of charts, topographic maps and other publications rose to record levels. Apart from the Open House, 950 members of the general public visited MIC in 1979, buying 1325 charts, 652 topographic maps, and 259 List of Lights, Radio Aids, Tide Tables and other publications.



Marine Information Centre - busier than ever!

We are presently stocking 725 editions of Canadian charts, 60 marine publications (Sailing Directions, List of Lights, etc.) plus topographical and special purpose maps and about 50 different general information brochures and pamphlets.

Chart Production

The Chart Production Unit's objective of getting as much information out to the mariner as quickly as possible continued in 1979. Forty-seven new CHS field sheets and 528 plans and drawings from other agencies were received and processed. This resulted in the production of 13 new editions, three new charts, 97 Notices to Mariners, and 13 chart patches.

The acquisition of a process camera in February and its immediate installation, calibration and utilization is a tribute to the ingenuity of our photomechanical specialist. The reprographic unit is now being fully occupied, catering to the needs of all Central Region's divisions and other groups at the Canada Centre for Inland Waters. Cartographers were assigned, on a rotational basis, to the unit for training in reprographic processes and to assist with production.

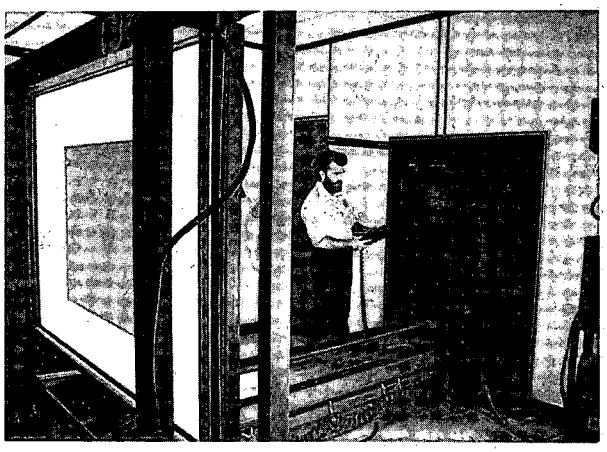


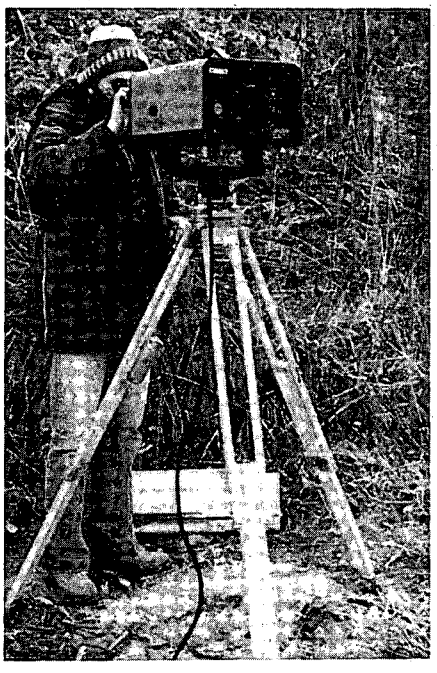
Chart Production Unit - Process Camera

Four cartographers attended Cartography I courses in Ottawa and one cartographer was assigned for a short period to Central Region's Revisory Survey. The exchange program with NOS continued with a cartographer from Burlington spending six weeks in Rockville and a U.S. cartographer coming to Burlington for two months.

As usual, the Cartographic Unit was involved in a great number of special projects highlighted by a mass of material produced for the Open House held in April. Cartographer Al Gris is to be congratulated for his winning design of the official Open House logo which appeared on all official documents and buttons for distribution to the general public.

Hydrographic Development

The Central Region Hydrographic Development Section supports hydrographic and cartographic activities by investigating and implementing new equipment and techniques. This year's efforts centred around computer-assisted cartography and hydrographic data collection.



Measuring Distance by LASER

GOMADS

A major effort during the year has been the implementation of the GOMADS/Digitizer hardware and software. The GOMADS interactive editor was working in April on the PDP-11/34. The Gradicon digitizer and PDP-8/E computer were working by November and system tests are underway. The equipment, when it reaches production status in 1980, will provide digitizing and interactive editing capabilities to the cartographer for his chart, and to the hydrographer for his field sheets. In addition, the hydrographer will be able to run interactive survey computation programs on the PDP-11/34 computer and plot titles, lattices and rough field sheets (for checking purposes) on the Calcomp 960 plotter.

NavBox

A contract to manufacture INDAS (Integrated Navigation and Data Acquisition System) units was awarded to D. G. Instruments in Ottawa late in 1978. The development group has been involved in software changes to improve computer precision and data entry techniques. These changes were also made to the four prototype units which were used successfully on Lake Erie and Lake Nipissing surveys this summer. The first production NavBox was delivered in September 1979. A total of six units and one test jig were delivered by the end of the year.

Rho-Theta

Development of the Rho-Theta survey system has been postponed due to personnel shortages. Because of its semi-automated nature, the program will be re-evaluated before any further work is performed on the project.

Cyber 171

During the year the CDC 3170 computer at CCIW was replaced by a Cyber 171. Existing programs had to be converted by the development group to work on the new system.

Gerber 22

Over 200 field sheet base plots, circular and hyperbolic lattices, field sheet titles, sounding plots and miscellaneous items have been plotted on the Gerber-22 plotter in support of field surveys and cartographic projects.

Data Logging

To improve data logging performance and reliability, the development group began work on a 'smart' cassette logger this year. The prototype, which is designed to work in conjunction with NavBox, incorporates an MFE Model 450-B tape transport, an MFE parallel interface board and a custom-designed microprocessor-based controller board. It will be tested next summer. In addition, solid state methods of logging hydrographic data are being investigated.

Sounding Selection

The development group has been investigating alternate methods of selecting soundings from digitally recorded data. A bottom representation scheme has been successfully used in conjunction with an overplot removal program to process Hudson Bay data. The method produces a clean, condensed data base that is useful to disciplines other than hydrography. The system will require further tests before being used in a production capacity.

Miniranger Signal Strength Versus Accuracy

Preliminary inquiries into the accuracy of miniranger distances as a function of signal strength were

conducted. Development of a signal strength indicator for the miniranger will be pursued.

Tides, Currents and Water Levels

Field Surveys

The Tides, Currents and Water Levels Section continued to obtain tidal data from the Arctic Islands with a survey during the winter of 1979. A number of Aanderaa pressure gauges were deployed through the ice for a month-long period in Sverdrup Basin, Queens Channel and Wellington Channel as shown in Figure 2, and returned eight records which will be used to determine the characteristics of the tide in these areas. This project is funded from the Hydrographic Arctic Research Project with the objective of carrying out a multi-year, comprehensive tidal survey of the whole of the Canadian Arctic Islands.

During the summer of 1979, a current survey of the St. Lawrence River between Lake Ontario and Montreal was undertaken. The objective of the survey is to provide current information from the Canadian portion of the river suitable for navigational applications and for publication on charts and in sailing directions. A combination of fixed-point current metering and near-surface drogue observations is being employed to obtain data. Operations in 1979 extended from Kingston downstream almost to the Brockville Narrows. The survey should be completed in another two years.

Aanderaa and Ottboro gauges were loaned to a number of agencies during the year for surveys in Lancaster Sound and Navy Board Inlet in the Arctic Islands; in Inoucdjouac, La Grande River and Attawapiskat River in Hudson Bay/James Bay; and in the Bay of Quinte, Hamilton Harbour and Lake Erie in the Great Lakes.

Gauges were supplied to hydrographic field parties working on Lake Nipissing and the St. Lawrence River. It is significant to note that hydrographic survey parties operating on Lake Superior, Lake Huron, Lake Erie and Lake Ontario this year obtained water levels for reduction purposes directly from Tidal Acquisition and Telemetry Systems (TATS) installed in permanent gauging stations.

Permanent Gauging Stations

Tidal Acquisition and Telemetry Systems have now been installed in 13 permanent gauging stations, eliminating all but one of a system of maintenance-prone data transmitting units which stored data on punched paper tape for transmission over Telex terminals. The TATS units, although requiring maintenance visits to solve initial start-up problems, are now operating virtually maintenance-free and are supplying data for the CHS water levels database in Ottawa. Installation and maintenance work is carried out by the Region. The operation of all other automated equipment, including 18 teleannouncer and nine remote telemetry units, continues to be carried out under contract by Marinav Corp.

Construction activities at permanent gauging stations included: the reconstruction of the stations at Neuville and St. Francois d'Orleans on the St. Lawrence River in connection with wharf repairs; the installation of a bubbler system at Point Pelee on Lake Erie, where littoral drift has blocked stilling well intake pipes; and the construction of a new gauging station at Brockville on the St. Lawrence.

Support for the bench mark maintenance program was received from Geodetic Survey of Canada in the form of deep bench mark installations at ten sites on the St. Lawrence River where the instability of ordinary bench marks has been a problem.

Negotiations with the Department of the Environment for a possible re-distribution of authority for permanent gauging continued without being resolved by year's end.

The Great Lakes Water Level Bulletin is published and distributed free of charge to approximately 2000 subscribers by the Section. Data for this bulletin is obtained from the TATS units installed at the master gauge site on each of the Great Lakes and at Montreal Harbour.

Coordinating Committee for Great Lakes Basic Hydraulic and Hydrologic Data

The Section represents CHS on the Vertical Control-Water Levels Subcommittee of the above committee. Major activities this year included the publication of a new edition of the committee report on the establishment of International Great Lakes Datum and planning for a re-evaluation of this datum.

Tidal Instrument Development

Development personnel were involved last winter in fabricating and testing various spike transducer configurations aimed at improving through-the-ice sounding techniques. Field work was carried out at Resolute, NWT.

Two items are presently being developed as add-on features for TATS units. One is a single circuit

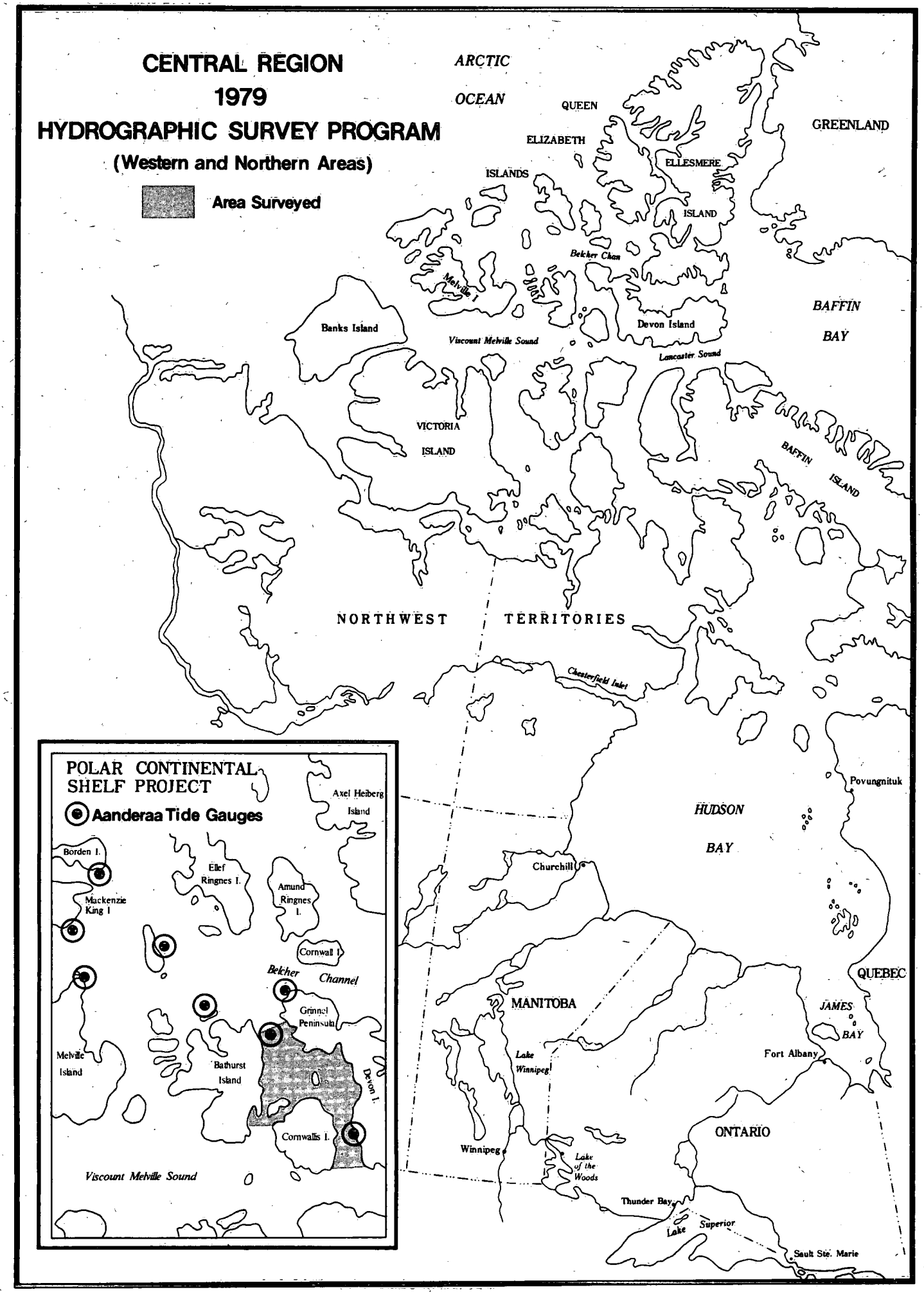

CENTRAL REGION
1979
HYDROGRAPHIC SURVEY PROGRAM
(Western and Northern Areas)
Area Surveyed
ARCTIC
OCEAN
QUEEN
ELIZABETH
ISLANDS
ELLESMERE
ISLAND
GREENLAND
Belcher Chan
Melville I
Banks Island
Viscount Melville Sound
Devon Island
Lancaster Sound
BAFFIN
BAY
VICTORIA
ISLAND
BAFFIN
ISLAND
NORTHWEST
TERRITORIES
Chesterfield Inlet
POLAR CONTINENTAL
SHELF PROJECT
Aanderaa Tide Gauges
Axel Heiberg
Island
Borden I.
Ellef
Ringnes I.
Amund
Ringnes
I.
Mackenzie
King I
Cornwall I
Belcher
Channel
Grinnel
Peninsula
Melville
Island
Bathurst
Island
Devon I.
Cornwallis I.
Viscount Melville Sound
HUDSON
BAY
Povungnituk
Churchill
QUEBEC
MANITOBA
JAMES
BAY
Lake
Winnipeg
Fort Albany
ONTARIO
Winnipeg
Lake
of the
Woods
Thunder Bay
Lake
Superior
Sault Ste. Marie

Figure 2

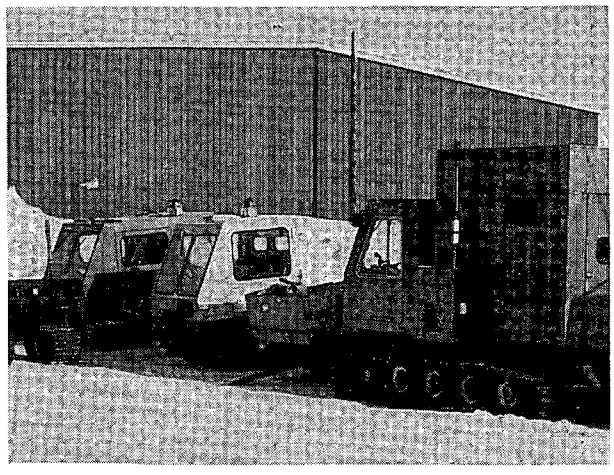
board teleannouncer and the other is a float switch device to provide a height comparison for the levels obtained from the primary TATS sensor.

Development of a low-power water level recorder for hydrographic survey applications continued as a major project. This unit will be based on the RCA Cosmac microprocessor, with the capability of being programmed to interface with a variety of sensors. Methods of entering input parameters (i.e. communicating with the unit) and storing and transporting data are still being explored.

Hydrographic Arctic Research Project (HARP)

HARP has allowed a significant amount of hydrographic research and development in Arctic transportation problems. Funding is provided by the Interdepartmental Panel on Energy R&D through the Office of Energy R&D Coordination, Transport Canada. Projects are being carried out by all regions with general coordination handled by Central Region. The total program has permitted necessary research to proceed at a pace not otherwise possible. Central Region's efforts have been directed primarily toward over-the-ice systems.

Work continued on the "spiked" ice-coupled transducers by way of an in-house research program conducted in Resolute, NWT, in conjunction with the PCSP. A comparison was made of several different transducer types and tips with a C-Tech model appearing to give the best results under most snow and ice conditions.



Polar Continental Shelf Project - Resolute Bay, NWT.

Two new tracked vehicles were purchased for the 1979 spring season and used as research platforms to carry out development programs on the sea ice. The existing vehicle which had been based at Rea Point was written off as being too costly to repair.

The digital echo sounder contract to replace the Edo 9040 presently in use has been cancelled because of corporate problems within the company which had been awarded the contract. Budget restraints have now reduced this project to a low priority.

The Marine Arctic Route Reconnaissance System (MARRS) in modified form underwent field trials in Bedford Basin to evaluate its performance. Although not designed to operate under the conditions encountered, the results proved to be of sufficient quality to warrant further trials in an Arctic environment. Further development is anticipated if the system meets its specifications during upcoming Arctic trials.

An unsolicited proposal by Huntec ('70) Ltd. has been accepted which by 1981 could result in the design of a prototype continuous profiling system for use in ice-covered waters. Initially, Huntec will develop, using non-linear acoustic techniques, a new class of electro acoustic transducers. In addition to measuring water depth, this system will provide information on ice thickness, ice quality, the interface between the bottom of the ice and the water, and on the sub-bottom to a depth of about a metre.

A major problem encountered during Arctic Surveys is the supply of suitable electric power for portable positioning systems. It is extremely expensive moving generators and fuel around; batteries drain in a few days and replacements have to be transported to the sites usually by helicopter. The Marine Electronics Section of Central Region, R&D Division, has solved this problem by developing a Solar Power System.

A highly portable solar panel (60 cm x 60 cm) and a simple mounting arrangement are combined to supply 24 volts direct to RPS or Minirangers. Development work is continuing on a larger system capable of working under low sunlight conditions (see R&D Section, p. 24).

Plans for 1980

The co-operative program with Earth Physics Branch, EMR, will resume as part of the Polar Continental Shelf Project's 1980 winter survey. Tracked vehicles and helicopters, positioned by Decca and Miniranger, will be used to survey M'Clintock Channel, working from north to south.

As neither a charter vessel or C.C.G.S. NARWHAL will be available in 1980, the summer hydrographic field program will be confined to the southerly areas of the Region. The surveys of Lake Nipissing, Lake Erie and the St. Lawrence River will continue. Revisory surveys will be carried out on the

Winnipeg River as well as on those charts scheduled for production in 1981.

Work will begin in the North Channel in Lake Huron and surveys of the major harbours in Georgian Bay will be carried out. At the request of MOT, the Region will be responsible for the precise positioning of ships during the evaluation trials of PRANS in the St. Lawrence River near Prescott. These trials will last about a month beginning some time in May.

During 1980 the Hydrographic Development Section will begin to phase out its heavy involvement with computer-assisted cartography as the GOMADS/Digitizer systems come on-line. In the area of data acquisition, development of the prototype cassette logger should be completed and field tests will be conducted. Field support for INDAPS surveys will be provided, as well as support for surveys using NavBox units. Miniranger accuracy/signal strength questions will be resolved, and solutions recommended. The bottom representation sounding selection method will be fully tested. The Section will also continue to provide support for Arctic development projects.

The Arctic tide-gauging program will continue in 1980 with the deployment of Aanderaa instruments during the winter survey of the M'Clintock Channel. The current survey of the St. Lawrence River during the summer will concentrate on the area between Brockville and Cornwall.

If funds are available, development will proceed on a new generation submersible tide gauge. A prototype of the portable, low-power gauge for hydrographic field use should be completed and field tested in 1980, as will the TATS teleannouncer and height comparison switch.

Three new charts and 14 new editions, including multi-strip charts of the Ottawa River and Trent-Severn Waterway, are scheduled for production in 1980.

Interactive editing of charts by cartographers should become a reality as the GOMADS/Digitizer system reaches production status in the coming year.

New Charts Published in 1979

No.	Title	Scale	Date	N.C./N.E.
2100	Lake Erie/Lac Erié	400 000	Nov. 2 '79	N.C.
5510	Povungnituk et les approches/ and Approaches	60 000 Inset 30 000	July 13 '79	N.C.
1552	Ottawa River - Portage-du-Fort To/à Ile Fraser	25 000	Sept. 14 '79	N.C.
	New Editions Published in 1979			
1415	Lake St. Lawrence	25 000	July 6 '79	N.E.
2025	Bobcaygeon to Lake Simcoe	Sh.1&2 20 000 Sh.3 30 000		N.E.
2042	Welland Canal	15 000	Mar. 23 '79	N.E.
2062	Oshawa to/à Toronto	72 900	Apr. 13 '79	N.E.
2067	Hamilton Harbour	12 000	Sept. 14 '79	N.E.
2110	Long Point Bay	50 000	Sept. 21 '79	N.E.
2181	Harbours in Lake Erie/ Havres du Lac Erié	Insets	Apr. 27 '79	N.E.
2205	Killarney to/à Little Current	40 000	Oct. 5 '79	N.E.
2314	Lakehead Harbour	20 000	May 18 '79	N.E.
6023	Lake of Bays	25 000	May 18 '79	N.E.
2000	Lake Ontario/Lac Ontario	400 000	Oct. 26 '79	N.E.
1512	Ottawa to/à Smiths Falls	20 000	Apr. 27 '79	N.E.
1513	Smiths Falls to/à Kingston	20 000	Oct. 27 '78	N.E.

RESEARCH AND DEVELOPMENT DIVISION

Introduction

The principal program areas of the Division continue to be Physical Oceanography, Shore Properties Studies, Environmental Assessment, and Program Support. Toward the end of the year our ongoing involvement in biological studies on Hudson/James Bay were regularized by the secondment of a zooplankton biologist to the R&D Division. While the biologist's prime research interest is plankton community structures in both freshwater and marine environments, he will continue to provide contract liaison with the University of Guelph and will assist in developing biological programs for the sub- and high-Arctic.

At the beginning of the year, management and staff of the Division were heavily involved in reviewing the proposed ice research centre program originally to be situated in OAS Burlington. It was found that the lack of oceanographic, ice physics and meteorological components substantially weakened the document, and an interdepartmental review further recommended that the centre be located in St. John's, Newfoundland. Also during the year, the CCIW Physical Seminar Series was managed and, for the first time, firm operating procedures were established. The Region's Science Program Review and Evaluation exercise was coordinated, requiring attendance at and organization of a number of regional and national meetings, culminating in the two-day National Science PRE meeting held at CCIW in November. At the urging of this and other Regions, a National OAS Arctic Policy and Program Coordination Committee was established with regional representation, to exchange information on science programs in the Arctic and to develop national oceanographic operating policies in the north.

A number of proposed Treasury Board submissions were reviewed during the year, including: Ocean Climate, Arctic Marine Transportation, and Contracting Out. A major effort was made by all scientific staff of the Division to prepare a detailed working paper on the Oceanography of the Central Arctic for the Arctic Science Initiatives Treasury Board Submission. It basically recommended that the physical and, to a lesser extent, biological research and survey expertise developed in the study of Hudson/James Bay be extended to the Arctic Archipelago, and in particular to the problem of water mass movement through the channels of the Archipelago.

Recently, a paper was prepared on Central Region's input to a major policy document on increasing R&D expenditure to 2.5% of the Gross National Product. Also quite recently, Division staff have been requested to assess the principal environmental problems and knowledge gaps as they relate to the renewed interest in offshore drilling in Hudson Bay. For the last four months, joint planning of a scientific symposium on Hudson/James Bay for April, 1981, has been carried out with staff at the University of Guelph and, more recently, the Quebec Region of OAS. A document was prepared on the vertical water motions in Goderich Harbour to assist the crown in its litigation of a damage suit and the Shoreland Management Guide of the Canada/Ontario Task Force, a six-hundred-page planner's guide, was reviewed for content and applicability.

Physical Oceanography

Physical oceanographic research was conducted in the Hudson and James Bay region, the middle estuary of the St. Lawrence River, Chesterfield Inlet, and the Arctic. The cumulative effects of the hydroelectric developments on the freshwater budget of the Hudson and James Bay region were studied. Winter studies were conducted off the La Grande and Great Whale Rivers to examine the horizontal and vertical extent of their freshwater plumes under the ice. Current and CTD data collected in the St. Lawrence River estuary were published and are being used in an analytical study of internal wave structure and propagation. Most current and CTD data collected in Chesterfield Inlet during the summer of 1978 have been processed and the results will be used to verify the salinity intrusion and tidal propagation model research of the Inlet. An Arctic survey in the Sverdrup Basin was conducted using the base camp facilities of Panarctic Oil Limited's drilling site "Whitefish". The survey collected current and CTD data to add to the Arctic data base needed to describe the circulation and magnitude of tidal and non-tidal motion in the Archipelago.

Hudson Bay - James Bay System

Central Region has been conducting physical oceanographic research in Hudson and James Bays to study the changes to the marine and estuarine environments caused by runoff modifications associated with hydroelectric developments. Major developments on the La Grande River and the Nelson River are in

You don't have to leave home to freeze in the Arctic - Burlington Beach

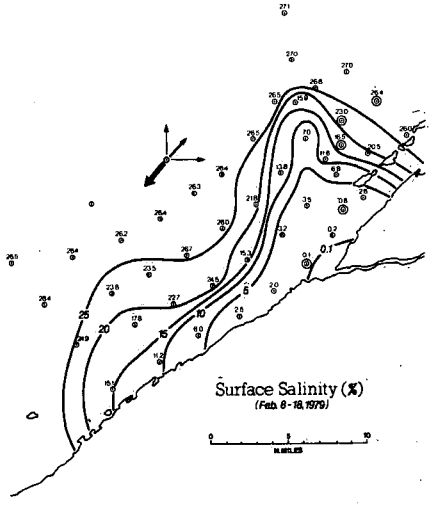
progress and developments on the Rupert River and the Great Whale River are in the planning stages. The four hydroelectric developments will cause temporal and spatial changes in the freshwater input cycle, with the main change occurring during the winter months when the regulated outflow rates will increase the normally low winter runoff rates to values comparable to those in the spring. The runoff into the Nelson River delta will increase 52% in the winter while the La Grande River will increase 500%. For the total Hudson Bay region, the winter runoff will increase by 50% with James Bay's contribution being twice as large as that of the Nelson River delta. Volumetric estimates of freshwater and heat contents were calculated for Hudson Bay and James Bay using oceanographic data from representative stations.

For James Bay the mean freshwater layer thickness was 6.25 m, representing a residence time of 10.2 months for a mean summer freshwater input rate. For the total Hudson Bay region a freshwater layer of 4.66 m was observed, representing a residence time of 4.1 years. The change in the Hudson Bay heat content between the winter minimum and the summer maximum could be accounted for by the solar radiation input minus the heat required to melt the winter's snow and ice cover. Other contributions to the heat budget over this time period, namely ice transport, advection, and heat from runoff, were insignificant. For the James Bay heat budget a similar balance was found, except that heat loss due to advection into Hudson Bay became a significant factor as well.

Since the major changes caused by hydroelectric developments in the freshwater budget are occurring in the winter periods, the larger portion of our research and field projects has concentrated on the winter months. Current meter results show that the freshwater effect on the circulation is caused by the dilution (horizontal density gradients) of the saline water and not by the addition of freshwater directly. The changes in the freshwater input rates will alter the winter circulation of James Bay while the other major contributor to the circulation, wind stress, will be greatly reduced by the ice cover. The changes in freshwater input will increase the magnitude of the circulation north of the La Grande River as a result of the increased horizontal density gradient. On the other hand, the southern portion of the bay will experience a decrease in the level of circulation.

Freshwater Plume Studies

The 1979 research on freshwater plumes under an ice cover involved both analytical and numerical modelling as well as field work. The research is aimed at understanding the dynamics of a buoyant plume so that the characteristics and influence of any plume on its offshore region can be predicted. In particular the plume characteristics of rivers undergoing hydroelectric development in the Hudson and James Bay region are being investigated. Simple analytical models show that the circulation characteristics change from the inshore to offshore section of the plume. In the inshore section the circulation is dominated by the volumetric addition of fresh water while offshore it is determined by the dilution effect (horizontal pressure gradient). A more realistic numerical model is being developed which allows the coupling of the density changes caused by the plume and the plume's circulation. During past winter surveys, salinity and temperature profile data were collected for the total James Bay area to provide sufficient baseline data to compare with their distribution under post-project conditions. Because the main reservoir at LG-2 was being filled, the 1979 survey was provided with a unique opportunity to collect background salinity and current data without the presence of a plume. Data were also obtained off the Great Whale River where no strong coastal current exists and which has a different runoff rate. At both locations current meter profile data and time series current meter data were also collected.



Surface Salinity - Great Whale

The current profile data revealed that the freshwater plume is not only separated from the remaining water column in the salinity field but also in the tidal energy field. Tidal energy observed below the strong halocline was absent in the freshwater layer. The 1979 data is being used to calculate the interface slope, gradient Richardson number and freshwater volume. The physical parameters will be correlated to the phytoplankton and nutrient data that were collected during the same survey. Additional physical and biological data will be collected during a ten-week field survey in 1980 when the outflow of the La Grande River will be two to three times as great as the pre-project winter outflow rate.

Chesterfield Inlet Research

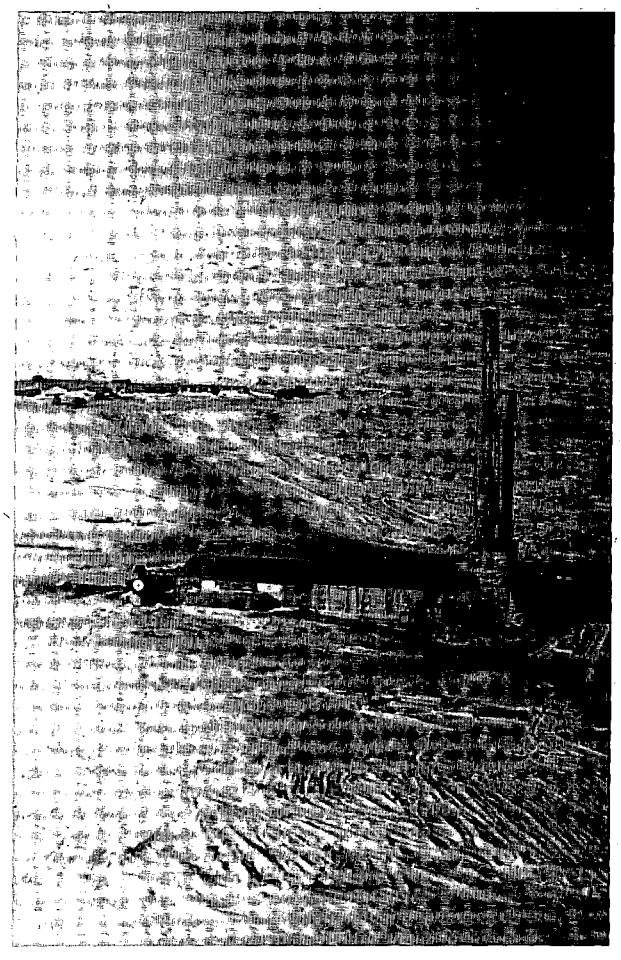
In 1978 a multidisciplinary oceanographic survey was conducted in Chesterfield Inlet. The two major goals of the survey were to provide tidal water level and current information to aid navigation in the inlet and to obtain data which would provide insight into the nutrient and plankton dynamics of a large sub-Arctic estuary.

At present, modelling work is being carried out to estimate current velocities and tidal heights over the whole estuary. By incorporating a numerical tidal model in a stochastic filter, it is possible to use the observed data to produce estimates of datum elevations and friction factors as well as enhanced predictions of the tides. For estuaries such as Chesterfield Inlet, where tidal ranges often exceed 5 m, causing current speeds sometimes greater than 2 m/sec, and where the geometry is extremely irregular, the use of statistical approaches can provide reliable values for unknown numerical model parameters.

During the past year the initial stages of modelling the nutrient and plankton distributions were completed. In general, it was found that nutrient distributions tend to parallel salinity or temperature gradients. Soluble reactive phosphorus and total dissolved nitrogen increase with increasing salinity and are nearly conservative substances. Nitrate, nitrite and silica, however, are uncorrelated with salinity and thus would appear to be nonconservative. The minimum biomass occurs near the mouth of the estuary and the maximum biomass is observed near the head of the estuary in a large embayment which possesses a high residence time. Biomass in the estuary tended to increase near embayments and decrease in areas of stronger two layer flow, suggesting that residence time is a key factor.

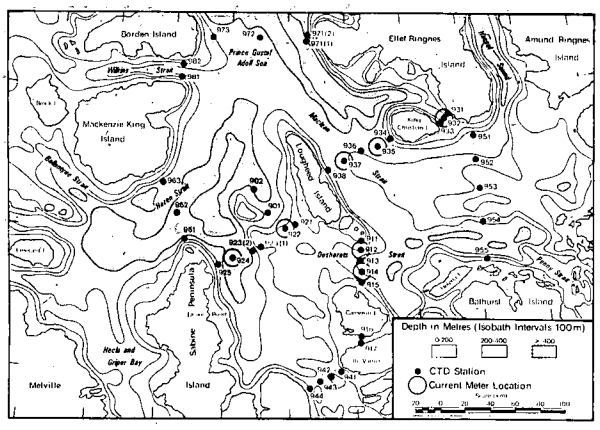
Arctic Oceanography

Continuing the program in support of Transport Canada's Energy R&D program on marine transportation of energy commodities, the 1979 Arctic oceanography project concentrated on the Sverdrup Basin. While the primary objective of this project was the collection of current and salinity/temperature data during a representative period of solid ice cover (March-May), the ultimate aim of the program is to study under-ice water movement. A further project was undertaken to analyze all current meter data in the Sverdrup basin, collected by both government and industry to improve understanding of the circulation through the Arctic Archipelago.



Panarctic Drilling Rig at Whitefish (stn. 901)

The field project was greatly assisted by logistics support from the Polar Continental Shelf Project, and through the generous cooperation of Panarctic Oils Ltd., who allowed our field crews to work from their camp at Panarctic AIEG et al Whitefish H-63.



1979 Arctic Oceanographic Survey Area

Fourteen current meters were moored on transects from Ellef Ringnes Island to Sabine Peninsula (Melville Island) and between Lougheed Island and Cameron Island. The currents are tidally dominated and are higher in Danish Strait (between Ellef Ringnes and King Christian Islands) and Desbarats Strait (between Lougheed and Cameron Islands), attaining speeds up to 24 and 22 cm sec^{-1}, respectively. In the wider and deeper channels between King Christian Island/Lougheed Island/Sabine Peninsula, maximum speeds were on the order of 10 cm sec^{-1}. Mean flows ranged from 5 cm sec^{-1} (Danish Strait) to less than 1 cm sec^{-1} in Desbarats Strait. The mean flow is generally southeasterly. CTD results in the Sverdrup Basin are interesting, showing regions of a relatively high degree of mixing, for example around Lougheed Island and several sills.

Biological Oceanography

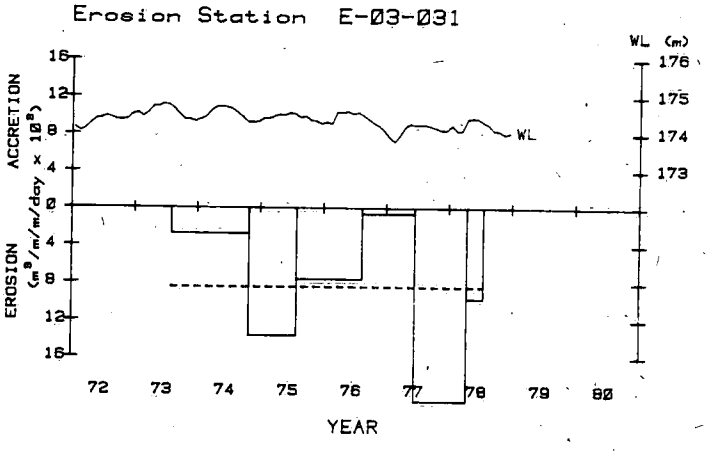
Plankton and benthic research has concentrated on the Great Lakes with more emphasis recently on Hudson Bay and Chesterfield Inlet through contract direction and Subvention liaison.

Great Lakes work, primarily for IJC Reference Studies, has related zooplankton seasonal production to temperature, and has investigated community structure to explore the importance of fish predation on zooplankton size and imbalances in phytoplankton production and zooplankton grazing. Some studies of benthic communities are in progress primarily to develop more precise methods of describing community structure, including grouping associated species and defining clusters of related sites, as methods to be applied to present and future studies of sub-Arctic and Arctic biota.

Surveys carried out in Hudson Bay and Chesterfield Inlet have increased our knowledge of the distribution of phytoplankton species across the Bay and similar studies of the biota of Chesterfield Inlet are starting to show the relationship of biota in a well mixed sub-Arctic estuary.

Shore Properties Studies

Shore Properties Studies is charged with documenting the rates and understanding the processes of shoreline dynamics and the associated shore property damages in order to improve the management of coastal resources. To do so, a comprehensive monitoring program is conducted on an annual basis along with a number of complementary studies.



Histogram showing volume of material eroded from a bluff during the survey period.

This was the fourth year of the five-year Canada/Ontario Great Lakes Shore Erosion Monitoring Program agreement. This program re-measures at least once during the twelve month period approximately 162 sites representing both onshore and offshore homogeneous reaches totalling about 2000 km of the erodible Great Lakes Canadian shoreline. The collected data is computer processed and further analyzed to enable assessment of the rates and processes of erosion and sedimentation. Along with these measurements, other pertinent information such as coastal zones land use changes as recorded periodically on sequential oblique aerial photographs, soil composition and vegetation inventories combine to provide temporal and spatial data sets over time periods of sufficient length that are useful in the detection of significant changes in en-

vironmental variables. These documented changes constitute an early warning system, and further form a keystone data basis necessary for wise habitat management and multiple use of the coastal zone. The preparation of the interim Shore Erosion Monitoring Program is well under way, and is expected to be published in the first half of 1980.

Special studies that complement the Monitoring Program were also continued this year. At Point Pelee National Park extensive monitoring of beach changes along the Park's 22 km Lake Erie shoreline continues, with increased emphasis on the consequences of an artificial nourishment scheme at the breach of the Park's northeast beach. Regular surveys and the offshore installation of a self-recording current meter programmed for the duration of the winter were used in this project. In addition, the annual report was submitted to Parks Canada to aid in their decisions relating to shoreline management. The effects of headland construction at Scarborough Bluffs and Fifty-Mile Point on Lake Ontario were monitored and findings presented in an unpublished report and a technical note. Estuarine erosion and sediment transport on the western shores of James Bay for the Hudson Bay Lowland Baseline Study and on the eastern shores for the impact of power development on the La Grande River are also being studied.

In addition to these research activities, this section responded to over one hundred requests for data pertaining to specific sites, distributed numerous brochures, and participated in Public Awareness Programs dealing with coastal zones. For similar reasons, active participation continues on the GLBC Standing Committee on Coastal Zone Management, the International Lake Erie Regulation Study, Coastal Zone Subcommittee, and PLUARG.

Environmental Impact Assessment

Under the Environmental Assessment and Review Process (EARP), federal projects are reviewed for any potential adverse impacts. Ocean and Aquatic Sciences, Central Region, generally provides comments regarding shore processes and fisheries. Because DFO is now a separate department, most reviews undertaken this year were associated with major project proposals or expansions to existing developments. Some of these projects and environmental concerns in which OAS has participated include the following.

Eldorado Nuclear Ltd. has been storing radioactive wastes at several locations in the Port Hope area since the 1940s. The present site is along the Lake Ontario shore at nearby Port Granby where wastes are placed in burial pits and covered with backfill. Bluffs have eroded to within three metres of one of the pits, seriously threatening the integrity of the storage system. If bluff recession is allowed to continue, the discharge of the radioactive contaminants is imminent. Decommissioning alternatives are being considered, including long-term stabilization or the complete removal of contaminated material to inland sites. It was recommended in our review that as an interim measure, toe erosion protection be placed at critical sections along the bluff and that groundwater and surface drainage be further regulated.

Landfill construction along Great Lakes shoreline is a relatively new concept in shore management. The Leslie Spit at Toronto (Outer Harbour East Headland) now extends over three miles in length. It was created to form an outer harbour, but it also lends itself to multiple purpose use, e.g. Aquatic Park. The design included 'hardpoints' at selected intervals for shore stabilization; however, this has proved inadequate and various protection methods have been proposed.

OAS participated in the review of the selected alternative which calls for the construction of another landfill connected to the existing structure. Armouring and groyne structures will be used for shore hardening. The embayment thus created will also be used for the disposal of dredged material from Keating Channel at the mouth of the Don River. OAS will continue to be involved in the review of the monitoring data (Toronto Harbour Commission) to comment on stability progress.

The plan to develop a 63-acre landfill to expand Oshawa Harbour remains a contentious environmental issue because of the potential impacts on nearby Oshawa Second Marsh. Several design alternatives have been modelled at the hydraulics laboratory of the National Research Council to derive optimum engineering strategies. Because the hydraulic model would not clarify environmental concerns related in particular to shore processes, OAS, together with the Environmental Protection Service, prepared a review of existing information. The report concluded that Oshawa is within a null point with respect to littoral drift; however, interpretation of shore accretion patterns generally supports a net drift direction toward the east. This was found particularly evident in comparison of relative shoreline positions at the harbour entrance on recent air photographs and especially historical survey plans. It was recommended, therefore, that artificial nourish-

ment of the beach fronting Second Marsh be required to prevent increased erosion resulting from a landfill operation.

A proposal by Ducks Unlimited and the Canadian Wildlife Service to dyke Big Creek Marsh, located at the base of Long Point on Lake Erie, was a unique review in that the Department of Environment had a dual role as both the proponent and reviewer. The project objective was to optimize wildlife management by regulating water levels within the marsh. Part of the plan was dependent upon the existing beach along the south limit of the marsh acting as a natural dyke. OAS emphasized in its review that this particular reach of shore is exposed to westerly storms, causing it to be very dynamic and have high rates of erosion. Because of this and other environmental concerns, the proposal has been postponed until more data becomes available.

Other major activities of the Section were related to work under the Canada/Ontario Shore Damage Survey Follow-up Program. This involved the completion and review of draft guidelines for the Shoreland Management Study and the distribution of Coastal Atlases to all senior academic institutions in Ontario.

Joint monitoring surveys with the Shore Properties Studies Section of R&D continued for the assessment of shore protective works at Long Point and a geomorphological classification of four estuaries in James Bay. Reports are currently in preparation.

Program Support

The four sections of Program Support, Ocean Instrumentation, Ocean Operations, Computing and Data Processing, and Survey Electronics, continued to provide support services to the Research and Development Division, other divisions of OAS, other OAS regions, and to other services at CCIW. Highlights of the year include operational and instrument support for two major oceanographic programs, conversion of in-house programs to a new Cyber 171 computer, the development of a successful portable solar power system for Arctic hydrography, and the development of an unmanned CTD/current profiling system for Arctic oceanography.

Oceanographic Operations

Two major oceanographic programs were conducted by the Ocean Operations group during 1979. The first was conducted in the La Grande and Great Whale areas between January 18 and February 28, 1979, and the second in the Sverdrup Basin between March 22 and May 11, 1979. In the La Grande-Great Whale program, five current meter and two tide-gauge moorings were installed and a series of 72 CTD and 35 biological stations were surveyed with a Bell 206 helicopter. The survey, working out of Fort George and Great Whale, Quebec, also completed six 18- and 25-hour CTD/current stations.

The second program, working out of the "Whitefish" drill camp of Panarctic Oils Ltd., utilized a Twin Otter and a 212 helicopter to install seven current meter moorings widely spaced in the Sverdrup Basin. A Bell 206 helicopter was used to survey 50 CTD stations and to complete one 13-hour station. An attempt to collect vertical current profiles with a sonically-oriented current meter was unsuccessful due to equipment malfunction.

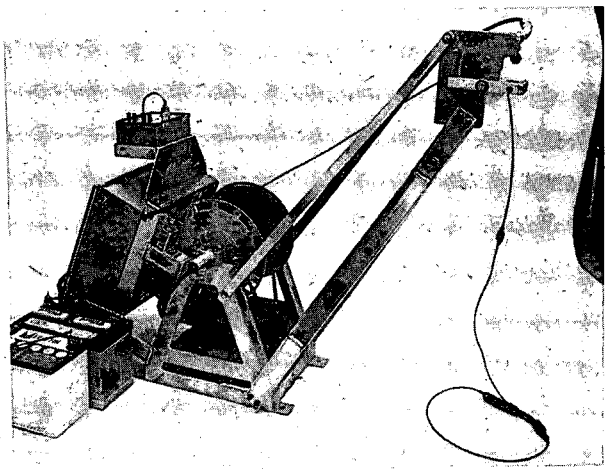
Ocean Instrumentation

During 1979, the Ocean Instrumentation Section serviced and calibrated instruments and provided field support for the oceanographic field programs conducted by the Division. The two programs used a total of 30 Aanderaa current meters and two Guildline CTD systems and consumed four man months of field support. The Section also serviced and calibrated 35 current meters and two CTD systems for the 1980 James Bay survey.

In addition, substantial support was provided to other OAS groups and to CCIW. A new Marsh McBirney electromagnetic current meter was tested and prepared for installation in a Shore Properties program at Point Pelee. A Guildline Arctic CTD system was prepared and calibrated for the Frozen Sea Research Group project for their use in the Beaufort Sea. Ten Aanderaa current meters were refurbished and loaned to CCIW for a program in Lake Erie and two Aanderaa current meters were loaned to OAS Quebec region.

The group also found time for several development projects. One of the Guildline CTD systems was modified to house the recording system in the deck unit. If this proves practical, the remaining decks will also be modified. Two Aanderaa current meters were modified for profiling applications with the inclusion of an inline vane and additional compass. This system was successfully used on the 1979 James Bay survey, although additional modifications have been made for the 1980 project. In preparation for the 1980 James Bay survey, a major project was undertaken to develop an

unattended profiling system to collect 26-hour CTD and current data from remote ice stations. The system, controlled by a microprocessor developed by Survey Electronics, automatically samples at 15 discrete depths every hour for a period of 26 hours up to a depth of 75 metres. The system can be programmed to perform various additional functions.



Unattended Profiling System

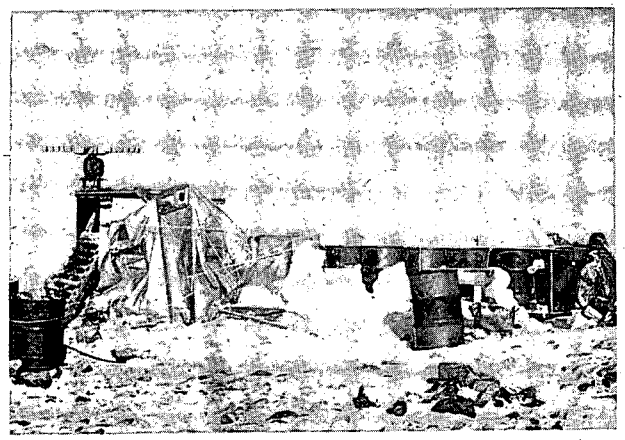
Finally, an Aanderaa Users Group newsletter was published and mailed to seventy users in fourteen countries.

Computing and Data Processing

The Computing and Data Processing Section continued to provide general computer programming and data processing in support of scientific research in the R&D Division. During the year considerable time was spent on conversion of existing programs and systems from the CDC 3170 to the new Cyber 171 computer. As a result of its larger size and greater speed, the new computer has reduced some of the requirements for outside computer facilities, particularly in the modelling area. New programs were developed and existing programs updated for in-field data acquisition and processing on the HP 9825 calculator. With the delivery of the Norpak MVP graphics terminal, development of software for interactive data editing has commenced. Data processing was also undertaken on the Chesterfield Inlet 1978, Hudson/James Bay 1979, and Arctic 1978 and 1979 data.

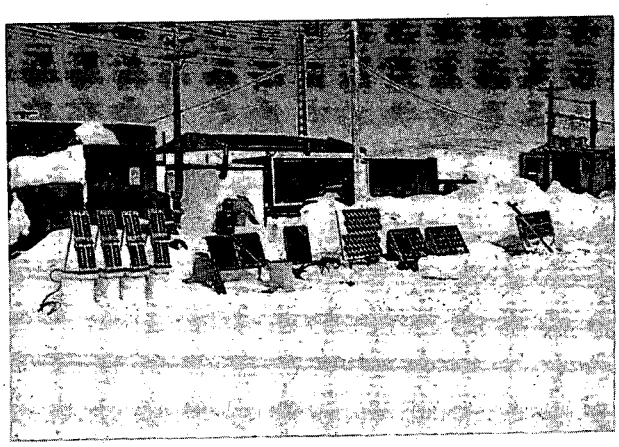
Survey Electronics

During 1979 the Survey Electronics Section provided field support to hydrographic surveys in the Arctic, on Lake Nipissing, Lake Erie, Lake Superior and on the St. Lawrence River. Electronic support continued to be provided to other services at CCIW and to numerous external agencies.



Bylot Island Radar Site

In addition to the yearly overhaul and field support programs, considerable effort was again spent on development activities. Additional tests were carried out on the Loran C antennas used on Lake Superior, resulting in further useful antenna configurations for low frequency systems. Results from this work will be published in a technical report early in 1980. Design work and field support was provided to an ice tracking program utilizing a modified marine radar off Bylot Island, NWT. Antenna control circuitry was designed and recording techniques investigated. A microprocessor-based controller was designed and constructed for the Unmanned Profiler developed by Ocean Instrumentation. The work commenced last year on solar power supplies for Arctic survey transponders resulted in the successful development of a system capable of powering a microwave transponder for a period of at least one month. The system is highly portable and easily assembled. Finally, a sophisticated test box was designed and constructed for testing Miniranger transponders.



Solar Panels Under Test at Resolute Bay, NWT.

GREAT LAKES BIOLIMNOLOGY LABORATORY

Introduction

Studies conducted by GLBL were expanded during 1979 to incorporate increased activity due to the signing, in the fall of 1978, of the revised Great Lakes Water Quality Agreement between Canada and the United States. The program changed in order to accommodate increased efforts in contaminants surveillance in Great Lakes biota and in research on the effects of contaminants.

Additionally, in response to the concerns over the effects of atmospheric pollutants, substantial diversion of effort was made to start new initiatives in the development of a program to address some of the fisheries concerns relating to lake acidification and contaminants derived from the atmosphere.

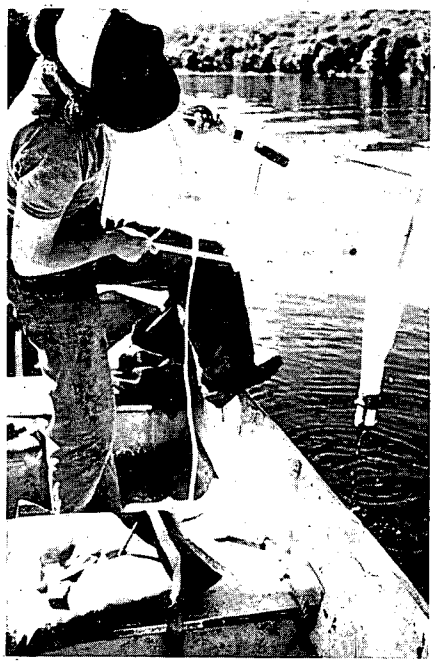
Structurally, the laboratory remains the same with all studies incorporated into three interrelated programs, namely Ecosystem Studies, Environmental Toxicology, and Surveillance. A general overview of the studies undertaken in these programs during 1979 is described under their respective headings.

Dr. J. R. Vallentyne (Senior Scientist, Fisheries and Oceans) was transferred from the Ontario Region Headquarters' staff to GLBL on April 1, 1979. He has been engaged in making presentations to various groups on the Great Lakes Basin as an ecosystem. His proposal for a conference on 'Global Resources' has been accepted and is being organized by Dr. Nicholas Polunin, as the Third International Conference on the Environmental Future (1981).

Ecosystem Studies

The Ecosystem Studies Program of GLBL is a collection of primarily field-based projects whose overall objectives relate to understanding the effects and consequences of man's environmental practices on the well-being of the freshwater ecosystem in general and the fisheries in the Great Lakes Basin in particular.

A reduced field effort was carried out in the Bay of Quinte in 1979, the eighth year that GLBL personnel have participated in this multi-agency, multi-disciplinary project. Briefly, the objective of the study, involving people from the Ontario Ministries of Natural Resources and the Environment, is to understand and determine the impact that reduced inputs of phosphorus have on the well-being of the fishery resource. As a result of intensive analyses of previous years' data, a reduced sampling program was designed for "Project Quinte" with no sacrifice in the ability to monitor system changes. It is anticipated that the information gained from this project will be of much use to the federal government's Fisheries Habitat Protection Program.



Sampling for zooplankton using
a Schindler-Patalas trap
in the Bay of Quinte

Two new research thrusts were initiated by the Ecosystem program in 1979, both of which are again co-operative with other government agencies. The first project represented a major new effort into the "acid rain" problem. In this project we will be examining the impact of the long-range transport of air-borne pollutants on aquatic ecosystems and, in particular, as these stresses impact the fishery. The project will be based at a new field site north of Sault Ste. Marie in the Algoma region and will be co-operative with two agencies from the Department of the Environment (National Water Research Institute and the Great Lakes Forest Research Centre), in addition to the Ontario Ministry of Natural Resources. In 1979, visits were made to over 40 potential study sites before a final choice was made of the Turkey Lake watershed study area. At year end, some V-notched weirs had already been installed and the first series of samples (i.e., biological, nutrient, soil, sediment, etc.) had already been collected and partially analyzed.

Peripheral and complementary to this study was a survey conducted by helicopter on over 50 headwater lakes in the Algoma region. The objective of this exercise was to provide information on the extent of the acid lake problem and to provide an accurate data base on which to judge future changes.

A second significant initiative in 1979 was the development of another GLBL satellite laboratory in the Owen Sound region. This lab will develop applied and research studies in Lake Huron and Georgian Bay in collaboration with the Ontario Ministry of Natural Resources. It is anticipated that this facility will be operational in the spring of 1980.

Environmental Toxicology

Algal Studies

It was previously reported that a mixture of ten metals at Water Quality Objective levels was toxic to several pure algal cultures. This study was extended to *in situ* testing of metal toxicity to natural phytoplankton in waters from the Bay of Quinte, Lake Ontario, and Batchawana Bay, Lake Superior. Factors affecting the metal toxicity were examined. The results of these studies should provide better criteria for establishing the Objectives, which were previously based on the response of individual metals.

Hexachlorobenzene (HCB) and pentachlorophenol (PCP) were found to be relatively more toxic to freshwater algae than heavy metals. Toxicity was determined using cell growth and primary productivity as indicators. Other parameters such as enzymes and cell membrane alterations are being investigated as possible sub-lethal indicators.

Invertebrate Studies

Studies on the effect of heavy metals on the biomass production kinetics of natural populations of freshwater copepods have continued through 1979. A significant seasonal cycle in toxicity for several metals has been observed to occur if tests are carried out using water from Lake Ontario. The interactive effects of metals in mixtures were also studied. Of the 15 binary mixtures possible among the metals Cd, Cu, Hg, Pb, Zn and As, only the zinc:arsenic combination demonstrated a large deviation between observed toxicity and calculated toxicity. The calculated toxicity was computed from the toxicity of single metals, assuming additivity in toxicity, where toxicity is measured as the increase in the inverse of the growth rate. Apart from the zinc:arsenic interaction, synergism, on the average, accounted for only a 17% increase in observed toxicity over calculated toxicity. The synergistic component in metal mixtures increased as the number of metals increased. A mixture of five metals resulted in an average increase of 53% of observed over calculated toxicity. The toxic unit concept (Sprague, 1970) cannot be used to correctly predict antagonism or synergism, but it provides a sufficiently close approximation of toxicity in mixtures to suggest its applicability to the setting of water quality objectives for mixtures.

Mixed function oxidase activity in invertebrates is presently under study in order to estimate the effect of organic pollutants on invertebrates, and the ability of invertebrates to detoxify pollutants. Another study, investigating the effects of lead and cadmium on the light responses of zooplankton, demonstrated behavioural changes at concentrations far below those causing mortality.

Fish Studies

Fish toxicology studies included completion of a 14-month arsenic study which demonstrated that waterborne arsenic concentrations up to 800 µg/L had no observable detrimental effects on rainbow trout. A cooperative study with the University of Guelph on the toxicity, pharmacodynamics and nutritional requirements of dietary selenium showed that a concentration of 13 µg/g in dry feed was lethal to trout while 0.07 µg/g was almost nutritionally deficient. Below feeding levels of 1.25 µg/g, Se levels in tissues were regulated, whereas above this level, residues increased markedly. Waterborne selenium was rapidly taken up by various life stages of rainbow trout. The rate of uptake increased in the following order: eggs > sac-fry > fry > juveniles. The amount of uptake from water was regulated, in contrast to uptake from food, but uptake from water was not influenced by tissue residue concentrations. Selenium was distributed throughout the fish with highest concentrations in the liver and kidney. Tissue depuration rates indicated a fixed fecal selenium excretion rate, passive excretion from the gills according to concentration gradients from tissue to water, and active excretion from the kidney.

Dietary triphenylphosphate caused deformities, low growth and mortalities in trout fed 10,000 mg/kg in dry feed, a change in condition factor and growth rates of 1,000 mg/kg, and changes in liver aryl hydrocarbon hydroxylase activities at lower concentrations. This preliminary experiment is continuing and will be follow-

ed by more intensive studies on other triarylphosphates.

Low temperatures (5-6°C) caused a marked increase in PCP toxicity to trout eggs and sac-fry. Higher temperatures (15-20°C) increased toxicity to fish that were feeding and actively growing. In addition, trout exposed during the egg stage were more sensitive to PCP than those exposed only after hatch.

A preliminary survey of lead exposure in lake trout from Lake Ontario indicated that a blood enzyme, erythrocyte δ-amino levulinic acid dehydratase, provided a more sensitive indicator of lead exposure than did whole-body lead analyses. A more intensive survey, emphasizing spatial, temporal and species variation, will be carried out in 1980.

To examine the fate of persistent organic contaminants, studies on the uptake of HCB from food, and the uptake of PCP from food and water by rainbow trout were initiated. Fish fed a dried diet containing 5 µg/g HCB, which approximates HCB levels monitored in Lake Ontario biota occupying the lower trophic levels, attained 6-8 µg/g after six weeks. Those fish fed diets containing 400-800 µg/g HCB had significantly higher HCB levels in their tissues which would suggest a low rate of depuration. A study is now in progress to determine the rate of depuration in trout.

Tetraalkyllead compounds, which are extremely toxic to aquatic biota, were found in significant levels in fish in Lake Ontario. These compounds were not detectable in sediments, water and phytoplankton. Attempts have been made to determine why these compounds were found in these fish, and whether they also occur in fishes from the other Great Lakes.

Trophic Dynamic Studies

A study on the dynamics of PCB's in a planktonic ecosystem was initiated using the Lake Column Simulators. Physical adsorption to inorganic and organic particles was an important mode of entry into food chains and can be affected by factors such as particle density, type and absorbent capacity. Zooplankton grazing and sedimentation are the most important routes for PCB transfer. Studies relating PCB dynamics to primary productivity have also been undertaken. A model that would predict PCB partitioning in natural ecosystems based on parameters such as loadings and characteristics of the particulate community is being developed.

Microbial Studies

A study has been initiated to examine the effects of low pH on the release and methylation of Hg, Pb, Se and As. Sediments from lakes in the Dorset area were being used for these studies. Effects of pH on microbial degradation and transformation of organic chemicals are also being studied.

Sampling for benthos using an Ekman dredge on Lake Dorset

Surveillance

Nutrient-related Studies

Lake Ontario chlorophyll a data for the time period 1974 to 1978 has been used to develop trends for seventeen zones established by the International Joint Commission. The chlorophyll a data was broken down into monthly values and detrended and deseasonalized. Regressions run on the data so far indicate that significant ($p > 0.05$) decreases in chlorophyll a have occurred in nine of the seventeen regions. Deseasonalized-detrended regressions have yielded significant ($p > 0.01$) equations for all seventeen zones, indicating that for many zones (especially the offshore area) a strong seasonal component exists. Chlorophyll a data for 1979 will now be added to the regressions to determine if the decreasing trends continue or have levelled off.

Phycological research concentrated on several main areas during the year 1979. Work continued and progressed towards the preparation of a Great Lakes' algal overview. Lake Huron received the most atten-

tion in data analyses and interpretation. 'Indicator species' surveillance was also organized for 1979 and collections were made in both the Canadian and U.S. waters. The 1978 data was analyzed qualitatively and resulted in the preparation of an interim report for the IJC. This report dealt with qualitative changes in the species composition of phytoplankton in Lakes Erie and Ontario from 1975-78. Research on the micromorphology of nannoplankton and ultraplankton continued with the use of scanning electron microscopy.

Work was completed on a project studying the biological availability of phosphorus from various geological materials in the Great Lakes Basin (bluffs, bottom sediment, suspended fluvial sediment). The work showed conclusively that shoreline material, although high in total phosphorus, is very low in biologically available forms. Some lake bottom sediments and most fluvial sediments supported algal growth, indicating highly available phosphorus.

A co-operative project with the Wastewater Technology Centre at CCIW was initiated in 1979. This was designed to examine the availability of phosphorus from sewage treatment plant effluents, and to evaluate the effectiveness of P removal by various treatment processes. The work was nearing completion at the end of 1979. Final results are expected in early 1980.

Contaminant-related Studies

In a continuing program to monitor the trends of toxic substances in the Great Lakes, samples of fish, lake trout, coho salmon, rainbow trout and rainbow smelt, were collected in Lakes Huron, Erie and Ontario. In addition, at several stations on each of the lower lakes, net plankton, zooplankton and benthic macroinvertebrates were obtained in order to examine the bioaccumulation of contaminants at lower trophic levels. All samples were analyzed for a variety of heavy metals, PCBs and persistent organochlorine pesticides. A limited number of salmonid samples were analyzed for mirex, phytodegradation products and chlorobenzenes. Currently, additional samples of fish from each of the Great Lakes are being analyzed for forms of organolead.

Techniques developed in the environmental toxicology laboratory of GLBL to measure the effect of waterborne lead on enzyme systems of fish were utilized in a field-oriented program. Blood samples from Lake Ontario lake trout were analyzed for total lead and erythrocyte δ-amino levulinic acid dehydratase (ALA-D) activity, the inhibition of which indicates an exposure to lead.

In a special study in Eastern Lake Ontario, the temporal dynamics of food chains (nearshore and offshore) were studied for a number of organic contaminants from spring to fall. Data indicate a spring increase in contaminant levels in the upper open water zone. This is subsequently transferred to the deeper zone, and eventually sedimented out, becoming available for accumulation in the benthos. Normalization of data to a fat basis did not eliminate differences between seasons nor between trophic levels, but did further point to a spring increase. While there are generally progressively higher levels of contaminants moving up the open water food chain, the differences are small. In addition, little congruence is apparent between the trophic levels on a temporal basis, as would be expected if food chain accumulation predominated. Levels of some contaminants are higher in *Pontoporeia* (a food organism) than its predator, *Cottus cognatus*.

Generally, levels of contaminants in the two food chains followed the order PCB > p,p'-DDE > Dieldrin > Mirex > Chlordane. Ecological magnification factors could only be calculated for PCB and Dieldrin and were of the order 10^5 - 10^6 and 10^3 - 10^5 respectively.

In another study, the stability of organic contaminants in frozen (-20°C) and freeze-dried fish homogenates was investigated. This has so far indicated significant losses of contaminants for both types of samples. Significant losses occurred in frozen samples of lean lake trout for p,p'-DDE (40%) and hexachlorobenzene (HCB) (25%), between 7 and 29 weeks of storage. For this same period, significant losses occurred in frozen fat lake trout for p,p'-DDE (40%) and HCB (35%). In freeze-dried samples for this same period, significant losses occurred in lean lake trout for PCB (47%), p,p'-DDE (60%), HCB (80%) and Dieldrin (33%). In fat lake trout, losses occurred for PCB (47%), p,p'-DDE (47%) and HCB (74%). Work is continuing on this project with the ultimate aim of developing a permanent archive.

The surveillance section, on behalf of the Great Lakes Fishery Commission, presented a questionnaire to fisheries agencies for the purpose of identifying contaminant research needs in the Great Lakes. The questionnaire arose out of concern for the alarming increase in the number of persistent contaminants in the Great Lakes, coupled with the lack of evidence

demonstrating effects of these substances on Great Lakes fish. The most commonly cited research need was the development of methodologies to assess the well-being of aquatic communities. GLBL, in response, initiated a preliminary biological monitoring program to complement contaminant surveillance and address fish health issues. Two programs are under way. The first is the development of a tumour identification handbook, which will help fisheries biologists identify commonly occurring tumours on Great Lakes fish. This handbook will be available for field testing in the spring of 1980. The second is a study to assess the significance of gonadal deformities observed in male lake trout from Lake Ontario. Samples of testes have been collected and sectioned and are currently being histologically analyzed to determine if these anomalies interfere with spermatogenesis.

Work has also been started on contaminant effects in natural phytoplankton populations. Attempts were made to study the effects of contaminants on algal micro-morphology. This work is continuing.

Preliminary experiments were carried out to study contaminant pathways through various size fractions of algae. Experiments were conducted in Lake Superior and Lake Ontario to study the effects of copper, vanadium and a mixture of these metals on natural algal populations. These kinetic studies have resulted in the development and refinement of our experimental design and methodology since such experiments are being carried out for the first time from the contaminants point of view.

Co-operation with Michigan Technological University has continued. Work focussed on the occurrence of phytoplankton in deeper waters of Lake Superior and also on the overwhelming dominance of micro-algae in the lake.

SHIP DIVISION

Operations

C.S.S. LIMNOS

After an extensive engine overhaul, LIMNOS was prepared for the first of 27 cruises which were carried out in 1979. This cruise was scheduled for March 12, but due to heavy ice conditions and the inability of the Burlington Bridge to operate, the sailing date was deferred until March 21.

Throughout the navigation season, LIMNOS participated in both scientific mooring and sampling cruises on Lakes Erie and Ontario, steaming a total of 13,543 nautical miles during the 272 operational days. On December 7 LIMNOS completed the final cruise for the 1979 season and on December 14 the vessel was decommissioned for the winter months.

C.S.S. BAYFIELD

After a winter refit, C.S.S. BAYFIELD was made ready for hydrographic surveys in Lake Erie and northern Lake Superior. Sea trials were carried out and, on their completion, the vessel sailed for Erieau on May 9. BAYFIELD participated in surveys in this area until June 2 when she proceeded to Rossport on the north shore of Lake Superior. Surveys continued in northern Lake Superior until September 6, at which time the vessel returned to Lakes Erie and Ontario to participate in Loran C evaluation which was completed on September 26.

At Burlington, BAYFIELD was once again outfitted for hydrographic surveys in the North Channel of Lake Huron. She sailed for Thessalon on October 14 and, with these surveys completed, returned to Burlington.

BAYFIELD was drydocked at Port Weller on November 5 and remained there for five days, subsequently returning to Burlington to decommission for the season on December 14.

C.S.S. ADVENT

On May 8, ADVENT sailed for Toronto to support a Humber College course which included demonstrating sonar, sounders, and automated equipment. At the conclusion of this demonstration, ADVENT proceeded to the IHTC Conference in Ottawa being held May 15, 16 and 17 where she proved to be a very popular feature. She returned to Burlington and, after spending two days at Toronto during the Canadian Institute of Surveying Conference, was outfitted for scientific work in western Lake Erie.

ADVENT arrived at Erieau on June 2 and continued operations in that area until October 29, at which time she returned to Burlington. During the summer months, ADVENT was withdrawn from service for three days in order to drydock for a damaged propeller housing. Subsequently, on the homeward voyage, engine problems forced the vessel to berth at Port Dover for two days while repairs were made.

On November 5, ADVENT was again drydocked at Port Weller for CSI inspection. After this was completed, she returned to Burlington and was decommissioned on November 19 for the winter months.

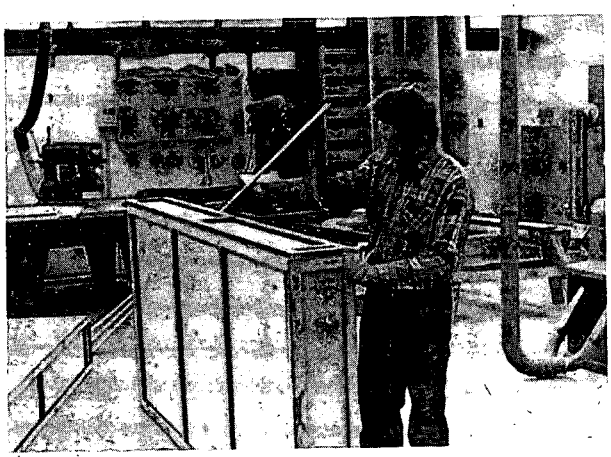
M.V. LAC ERIE

Once again the tug, M.V. LAC ERIE, was chartered, this year for a period of 160 days. She arrived at Burlington on May 7 and was outfitted for scientific operations in Lake Erie. On May 11, she departed for Erieau where scientific work was carried out until October 10. LAC ERIE returned to Burlington and, after equipment removal, was returned to the owners on October 12.

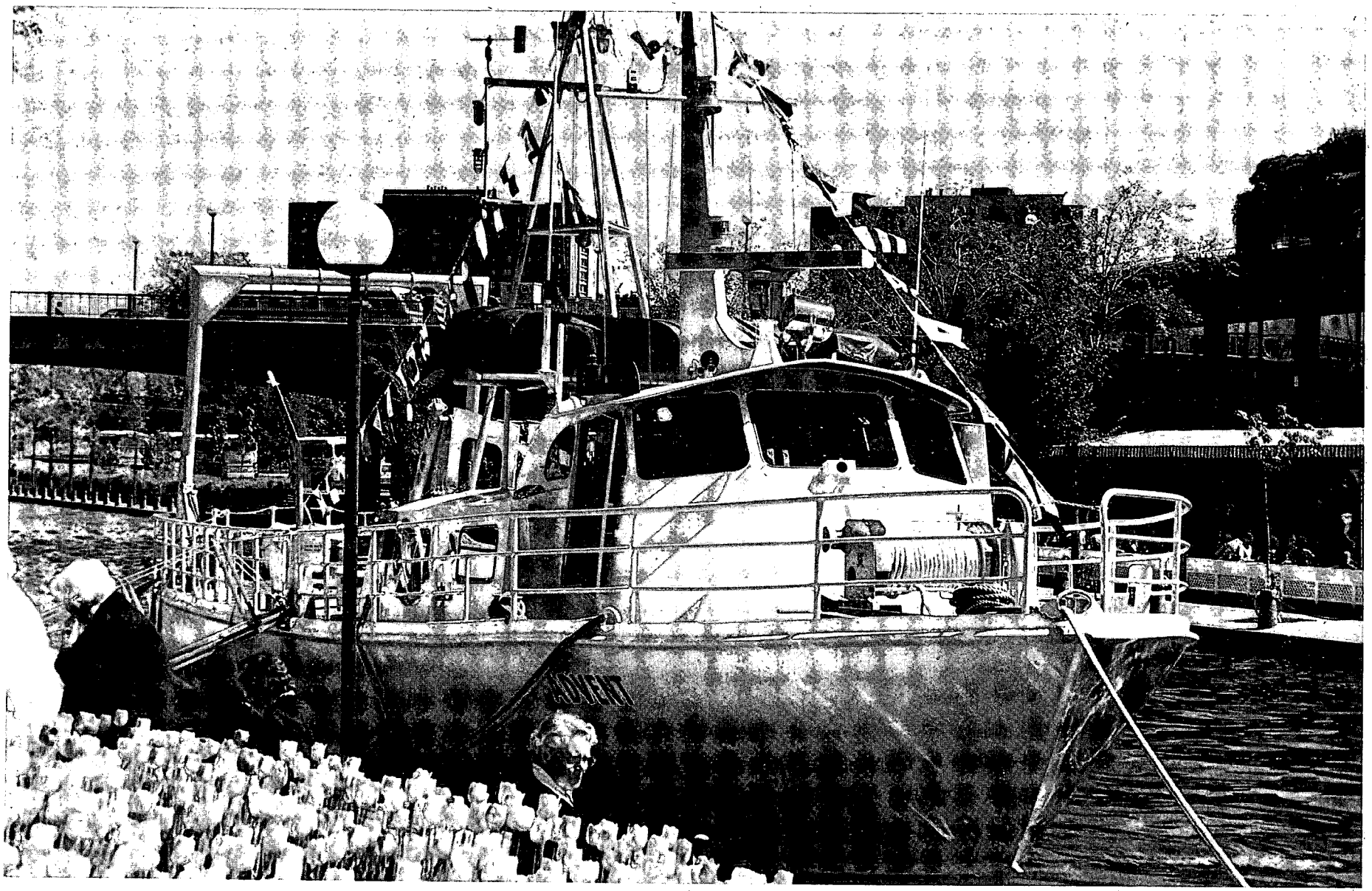
Hydrographic Surveys

Lake Erie Survey

This survey was based at Erieau until August 15, when all launches and equipment were moved to Port Stanley. Four Bertram launches and a Boston Whaler were road transported to Erieau where launch sounding commenced on May 8.



Survey crews also need boxes!



CSS ADVENT alongside Ottawa's National Conference Centre in May
for the International Hydrographic Technical Conference

C.S.S. BAYFIELD participated in offshore sounding from May 11 to June 2 before proceeding to Lake Superior.

Launch sounding continued until October 20, when the survey was terminated and all launches, crew and equipment returned to Burlington.

Lake Nipissing Survey

This was the first season for the two-year survey planned for Lake Nipissing. The survey was based at North Bay and used two Botved launches, two 21 ft Monarks, two Boston Whalers and two aluminum boats.

During the first week of May, all launches, crew and equipment were transported by road to North Bay. However, due to the prevailing high water situation on Lake Nipissing, no sounding was carried out until May 10.

Survey operations continued until October 15, when most of the launches and equipment were stored at North Bay and the crew returned to Burlington.

Kingston Survey

Launches NIMBUS, NAUTILUS, a Boston Whaler and one aluminum work boat were prepared to support this survey. The Boston Whaler and aluminum work boat along with related equipment were transported by road to the survey base located at Olympic Harbour.

C.S.L. NIMBUS and NAUTILUS departed from Burlington on May 24 after equipment trials and sailed to Olympic Harbour near Kingston. All the launches and equipment were used to survey the area between False Duck Islands and Simcoe Island. This was completed on October 16 and the launches returned to Burlington.

Personnel from this survey have highly recommended the Nelson type launches for offshore surveys. It was reported that these boats performed extremely well in conditions beyond the capability of the Bertram launches.

St. Lawrence River Survey

Four Botved launches, two Boston Whalers and crew were assigned to this program based at Gananoque. On May 1, boats and equipment were transported by road to the survey site and by May 8 launch sounding had commenced.

As a result of the extremely treacherous shoal-strewn waters along this section of the St. Lawrence, an inordinate number of propellers needed replacing.

Revisory Survey

Once again the Revisory Survey was carried out using one 19-ft fiberglass boat and a 17-ft Boston Whaler. A coxswain and seaman operated these boats in areas ranging from the North Channel in Lake Huron to the Ontario-Quebec border, including the Trent Canal system. The boats were towed on trailers between survey sites by two trucks provided by Hydrographic Division.

The field party left Burlington on May 7 and successfully operated throughout the summer months until October 22, when all boats and equipment were returned to Burlington.

Great Lakes Biolimnology Laboratory

Quinte Survey

Contrary to previous years, surveys in Lake Superior did not require the use of C.S.L. AQUA for the 1979 field season. Consequently it was decided that AQUA would be placed in service in the Quinte survey. The launch, which had wintered at Sault Ste. Marie, was made ready for the voyage and departed for Burlington on May 10.

Extensive hull and engine repairs were carried out at Burlington before the launch proceeded to Picton to replace C.S.L. SURF, which had been used on the Quinte Program since May 21. AQUA provided support to this program until September 28 when she returned to Burlington and was taken from the water for the winter months.

Acid Rain Survey

Acid rain studies were carried out in the Turkey Lakes using three aluminum boats and two 17-ft canoes provided by this Division. No ships crew were involved in this program except to deliver the boats and equipment to Sault Ste. Marie. A helicopter was used extensively for acid rain studies in Central Ontario during the month of October.

Research and Development Surveys

Shore Properties Studies

The Division provided support to Shore Properties Studies in Lakes Huron, St. Clair, Erie and Ontario. As in the past, a Crestliner boat was used for this program.

In James Bay, a 14-ft inflatable boat was provided in support of the Hudson Bay Lowlands studies. This

program consisted of a current, temperature and salinity study in the Attawapiskat River.

Local Launches

When the harbour and lakeshores were free of ice, C.S.L. SHARK was launched and put into service. SHARK provided support to various scientific programs throughout the 1979 season on Lakes Erie and Ontario.

C.S.L. BRUCE operated as the main SAR (Search and Rescue) vehicle out of Burlington, also providing support as required to scientific personnel working at the towers located off Van Wagner's Beach and for local water sampling programs.

Boston Whalers and small craft were supplied to various scientific groups from the Centre throughout the summer months. Working areas for these boats ranged from Central Ontario to Lake Memphremagog in Quebec.

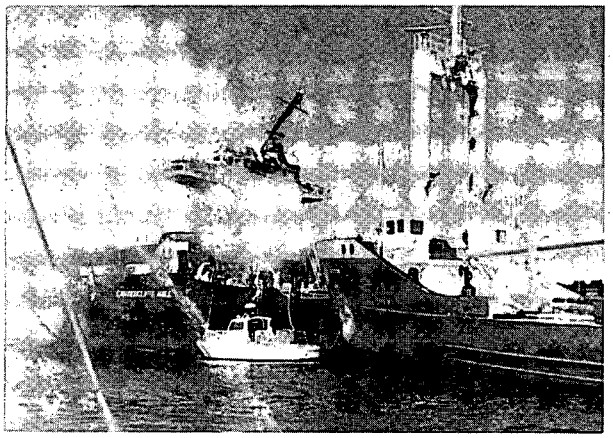
After all launches were decommissioned and removed from the water for the winter months, a Boston Whaler was made available when required to transport personnel to and from the scientific towers off Burlington Beach (Van Wagner's).

Search and Rescue

Preparations for the implementation of the 1979/80 SAR plan began as early as January as field plans were formulated. These were discussed with Headquarters personnel and also with representatives of Treasury Board, Canadian Merchant Services Guild and Public Service Alliance. As a result, negotiations were initiated to draft Letters of Agreement to accommodate the impact on current collective agreements - these were finally promulgated in July!

Meanwhile, a detailed program was prepared, new positions established, personnel engaged and the myriad of arrangements made for site locations, constant personnel movements, network communications, etc. and, to the amazement of all, the operation opened for business on schedule. All in all, a great deal of time and effort was devoted to an operation that appeared, on the surface, to be a relatively simple one.

One notable incident in June was the CARTIERCLIFFE HALL disaster in which BAYFIELD helped extinguish the fire on board while standing-by to rescue survivors. A commendation for the ship and crew was received from the U.S. Coast Guard commander, 9th Coastal District, for this action. In another incident, the life of an off-duty policeman was saved. Due mainly to the remoteness of the survey work, the total number of recorded SAR incidents -22 - was relatively low and, while a humanitarian might rejoice in this figure, the statistic-conscious planner might well take a more negative view and reason that the number of lives saved was hardly worth the cost - until the next disaster!



BAYFIELD at scene of CARTIERCLIFFE HALL incident showing U.S. Coastguard Cutter and C.C.G.S. GRIFFON

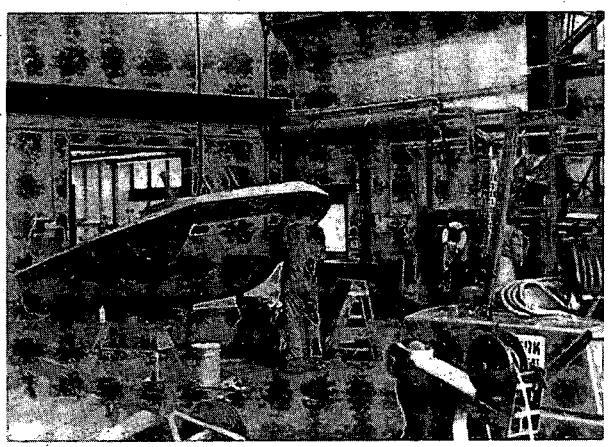
In retrospect, despite the inevitable tribulations associated with the birth and weaning of an entirely new program, the exercise must be considered a success in that virtually all objectives were achieved, commitments met, and a significant contribution made to the national SAR response capability.

Boatshop

Five events during 1979 served to disrupt the normal, smooth running boatshop schedule. The first was the CCIW Open House, for which the staff were called on to spend upwards of four weeks preparing and constructing various cabinets and displays for both DFO and DOE, helping to make the occasion a great success. This event was followed by the arrival at Burlington of C.S.L. AQUA en route from Sault Ste. Marie to Picton; she was found to have suffered bottom damage requiring extensive repairs before she could continue.

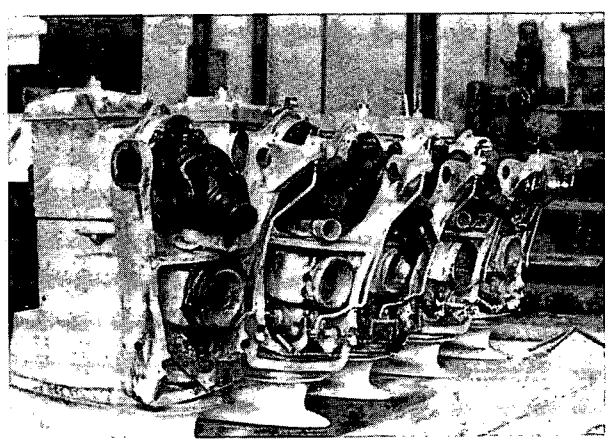
Approximately a month later, C.S.L. BROCK suffered extensive damage, the repair of which required gutting the hull and rebuilding the vessel from scratch.

The Rotork Sea Truck was next in line, developing a leak through the deck which allowed rain water to enter the foam sandwich inner bottom and waterlog the vessel.



At work in the Boatshop

Finally, C.S.L. SHARK grounded while dragging for a mooring that had drifted from its position in Lake Erie. During this operation she suffered hull and rudder damages. Repairs were carried out as a joint venture between boatshop staff and contractors.



Casualties awaiting surgery

Despite the foregoing, however, 1979 could be termed a successful year for the boatshop, due mainly to the excellent cooperation received from the field parties and the fact that the procedures instituted over the past several seasons came together during the year. First, there was the practice of taking a spare launch into the field and keeping it for that specific purpose, ensuring that as little survey time as possible was lost as a result of breakdown. Secondly, there was the retention of the major inventory of spare engines, outdrives and outboards at CCIW, with a minimum number taken into the field, necessary changes being made on a "good for bad" basis with the damaged units being returned immediately following a failure. This equipment was therefore repaired, ready for re-use, rather than being held in the field until all spare units were used up, thus spreading out the shop mechanics' workload throughout the year.

Another procedure which worked well and cut down lost survey time due to breakdowns for the second year in a row was the utilization of "mobile" field parties, who returned their equipment to base at regular intervals for running and preventative maintenance. As such, major failures of equipment were prevented.

C.S.S. LIMNOS

The effort to achieve a record-breaking third year in a row without a time loss breakdown was spoiled when 5½ hours were lost due to the failure of a main engine cooling water expansion piece.

The Austin Western five ton crane gave problems again this year; however, repairs were carried out by ships staff assisted by contractors and no time was lost.

C.S.S. BAYFIELD

The facility for paralleling main generators installed this year led to a highly successful operating season, marred only by a troublesome steering gear failure at the start of the season, which resulted in a 32-hour delay in transit. A further four hours were lost later in the season while repairs were being carried out to the voltage regulator on one main generator for a 38-hour time loss total.

The vessel went into drydock at the close of the season for a five year survey, the second time she has done so since she was acquired by the Department.

C.S.S. ADVENT

A trip to Ottawa and two trips to Toronto, in conjunction with the first Annual International Hydrographic Technical Conference and the 72nd Annual Meeting of the Canadian Institute of Surveyors, respectively, followed the winter repair and refit period. The vessel then departed for Lake Erie on scientific and search and rescue service.

One unscheduled drydocking and a blower train failure on the port engine marred the season, which ended with a scheduled drydocking for a five year survey.

REGIONAL MANAGEMENT SERVICE

Finance and Administration Division

During 1979 the following Departmental resources were expended in Central Region:

	$000				
Person/years	Salaries	O&M	Capital	Contributions	Total
198	4,991	2,658	735	2	8,386

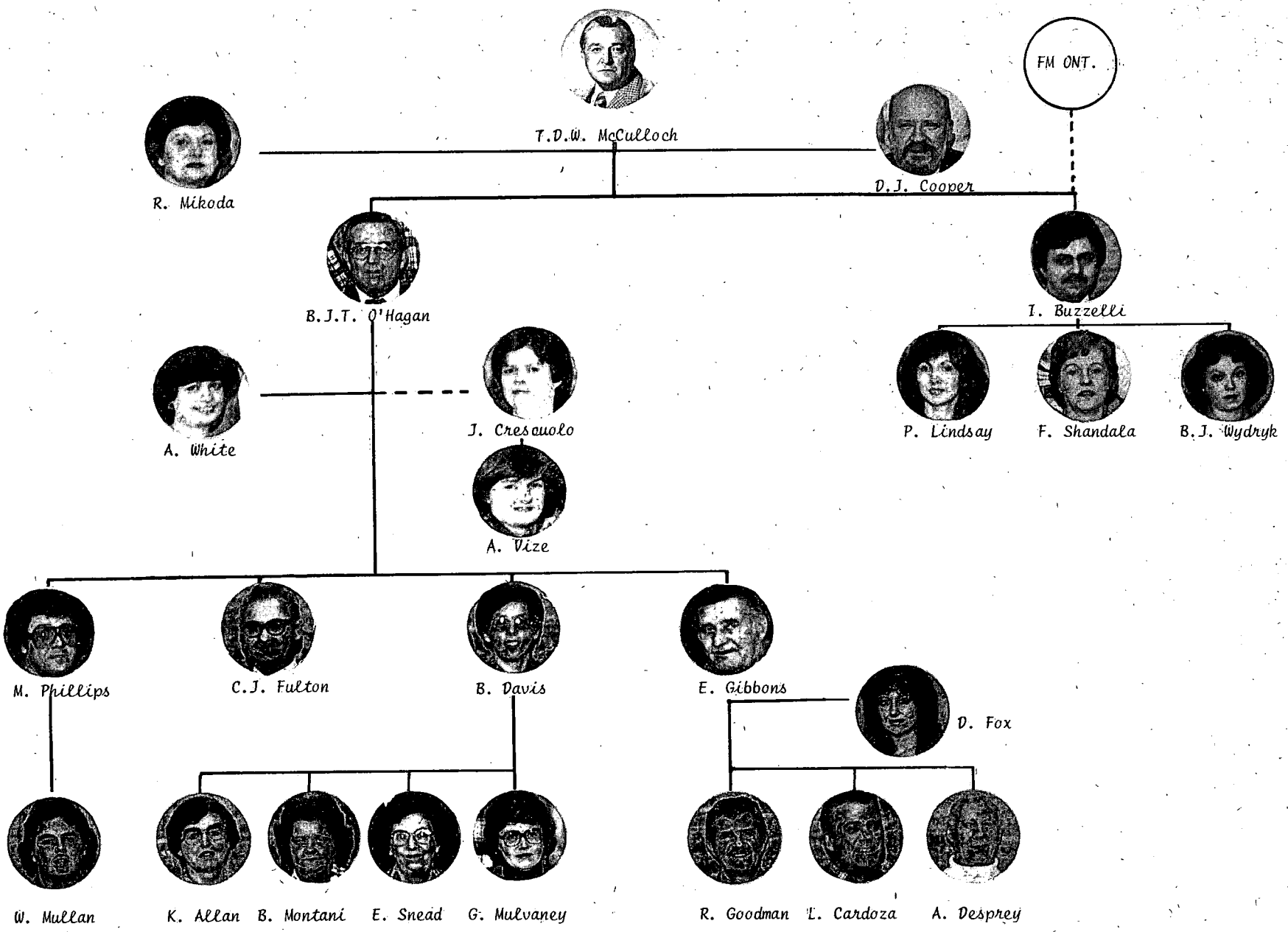
In addition, $654,000 was spent on behalf of other Federal Government Departments and the Province of Ontario.

Regional vehicles travelled a total of 576,978 km. There was one vehicle accident costing $475.00 to repair and resulting in an accident frequency rate of 0.17 per 100,000 km operated.

Reorganization of the warehouse area in the summer of 1979 provided much needed storage space and a sizeable marshalling area which is a necessity when assembling equipment and supplies for shipment to the field. A total of 129 tons of equipment was moved in and out of the warehouse during the year, principally in support of field operations. Approximately 3,000 requisitions having a value approaching $3,000,000 were processed through the procurement section, and equipment valued at $157,000 was sold through Crown Assets Disposal Corporation.

On July 1, 1979, a Fisheries & Oceans personnel organization was formed in Central Region. Administratively responsible to the Director General of Central Region, this group also services the Fisheries Management elements in Ontario. In 1979 they processed 113 staffing actions and 72 classification actions. Seventeen industrial accidents were reported in the year, five of which resulted in lost-time.

REGIONAL MANAGEMENT SERVICES IN REVIEW



PRESENTATIONS AND PUBLICATIONS

Hydrographic Division

Douglas, G. R. "Hydrographic Research in the Canadian Arctic." Presented at the First International Hydrographic Technical Conference, Ottawa, May, 1979.

Macdonald, G. D. The Origin of 'The Origin of the Species' (The Beagle Expedition 1831-1836). LIGHTHOUSE, Journal of the Canadian Hydrographers' Association, Vol. 20, 1979.

Tripe, R. "A Critical Review of Automated Hydrography within the Canadian Hydrographic Service." 72nd Annual Meeting of the Canadian Institute of Surveying, Toronto, May, 1979.

Douglas, G. R. "Through-the-Ice Hydrography." Meeting of the Ontario Society of Remote Sensing, Hamilton, Ontario, September, 1979.

Davies, P. Arctic Survey Uses Helicopter Mounted Spike Transducer. LIGHTHOUSE, Journal of the Canadian Hydrographers' Association, Vol. 20, 1979.

Knudsen, D. and D. Kimmett. "Impact of an Automated Water Level Data Acquisition and Telemetry System on River Basin Management." Canadian Society for Civil Engineering 4th National Hydrotechnical Conference, Vancouver, B.C., May, 1979.

Research and Development Division

Baird, S. D. "Aanderaa Current Meter Users Group Newsletter." Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Baird, S. D. and J. L. Anning. La Grande/Great Whale Winter Oceanographic Survey 1979 Field Report. Field Report Series #79-2. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Boyd, G. L. and W. S. Haras. Shoreline Monitoring Program, Point Pelee, Lake Erie. Interim Report, 1973-1978. Unpublished report, Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Brooks, D. J. Chesterfield Inlet Oceanographic Survey. Field Report Series #79-1. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Budgell, W. P. and A. El-Shaarawi. "Time Series Modelling of Storm Surges on a Medium-Sized Lake." Elsevier Oceanography Series, Vol. 25, Marine Forecasting, J. C. J. Nihoul, editor.

Coakley, J. P. and G. L. Boyd. Fifty-Mile Point Case History, I. Predevelopment Coastal Regime. Unpublished report, NWRI, Environment Canada.

Doekes, C. and F. W. Deys. HP-9825A - Interdata Model 70 Data Transfer Link. Technical Report Series #79-1. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Freeman, N. G. National R&D Policy - Central Region. Working Paper prepared for OAS Working Group, Ottawa.

Freeman, N. G. Vertical Water Motions - Goderich Harbour. Special Report prepared for the Department of Justice, Ottawa.

Freeman, N. G., G. S. Peck, J. R. Shaw, S. J. Prinsenberg, W. P. Budgell, N. H. Watson, R. L. Thomas and E. O. Lewis. Arctic Science Initiatives: Working Paper on Oceanography of the Central Arctic. Working Paper presented to the DFO Working Group, Ottawa, October, 1979.

Gottinger, R. and A. C. Zingaro. Computer Charting System. Technical Report Series #79-3. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Lewis, E. O. and R. D. Coons. "Photovoltaic Power for High Arctic Survey Applications". Presented at the NRC Seminar on Cost Effective Applications of Solar Photovoltaic Systems in the Federal Government, Ottawa, October 25, 1979.

Muir, L. R. Internal Tides in the Middle Estuary of the St. Lawrence. Le naturaliste canadien, Vol. 106, p. 27.

Muir, L. R. St. Lawrence River Oceanographic Survey 1977 Data Report: Volume I. Data Report Series #79-1. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Muir, L. R. St. Lawrence River Oceanographic Survey 1977 Data Report: Volume II. Data Report Series #79-2. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Peck, G. S. Arctic Oceanographic Survey 1979. Field Report Series #79-3. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Prinsenberg, S. J. Sound Velocity and Sounding Depth Error Distribution in Hudson Bay and James Bay. Technical Report Series #79-2. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Prinsenberg, S. J. and D. Collins. Hudson Bay/Great Whale Oceanographic Data Report Winter 1977. Data Report Series #79-3. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Prinsenberg, S. J. and F. W. Deys. Hudson Bay Oceanographic Data Report 1975, Volume 2. Data Report Series #79-4. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Prinsenberg, S. J. and R. Gottinger. Heat and Freshwater Contents in Hudson Bay and James Bay. Manuscript Report Series #8. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Prinsenberg, S. J. and G. S. Peck. "Physical Oceanography of James Bay During Winter." Abstract published in Atmosphere-Ocean. Presented at the Canadian Meteorological Society, 13th Annual Congress, May 30-June 1, 1979. University of Victoria, Victoria, B.C.

Roff, J. C., R. J. Pett, G. F. Rogers and W. P. Budgell. "Planktonic Ecology of Chesterfield Inlet, Northwest Territories - An Arctic Estuary." Presented at the Fifth Biennial International Estuarine Research Conference, Jekyll Island, Georgia, October 7-12, 1979.

Rukavina, N. A. and E. O. Lewis. "A Fixed Transducer System for Recording Nearshore Profile Changes". Presented at the ACROSES Workshop on Instrumentation for Currents and Sediments in the Near Shore Zone, Ottawa, October 24, 1979.

Shaw, J. R. "Impact of Environmental Assessments". Presented at the R&D Seminar Series, January 12, 1979.

Shaw, J. R. (principle author). Shore Property Hazards. A Canada/Ontario publication under the Shore Damage Survey Public Awareness Program.

Thomas, R. L. and W. S. Haras. Contribution of Sediment and Associated Elements to the Great Lakes from Erosion of the Canadian Shoreline. International Joint Commission PLUARG Technical Report, Task D, Activity 1.

Weaver, K. W. A Volumetric Analysis of Erosion Using Photogrammetric Contour Maps, Scarborough Bluffs, Lake Ontario. Technical Note Series #79-4. Ocean and Aquatic Sciences, Central Region, Burlington, Ontario.

Great Lakes Biolimnology Laboratory

Borgmann, U., C. Loveridge and R. Love. A rapid method for the estimation of, and some factors affecting, copepod production rates in Burlington Canal. J. Fish. Res. Board Can. 36: 1256-1264.

Borgmann, U., R. Love and C. Loveridge. Effect of metals on the biomass production kinetics of freshwater copepods. Can. J. Fish. Aquat. Sci. (in press).

Chau, Y. K., P. T. S. Wong, O. Kramar, G. A. Bengert, R. B. Cruz, J. O. Kinrade, J. Lye and J. C. Van Loon. Occurrence of tetraalkyllead compounds in the aquatic environment. Bull. Environ. Contam. Toxicol. (in press).

Chau, Y. K., P. T. S. Wong, G. A. Bengert and O. Kramar. Determination of tetraalkyllead compounds in water sediment and fish samples. Analytical Chem. 51: 186-188.

Gladish, D. W. and M. Munawar. The phytoplankton biomass and species composition at two stations in Western Lake Erie, 1975/76. Internationale Revue der Gesamten Hydrobiologie (in press).

Hodson, P. V., B. R. Blunt, D. Jensen and S. Morgan. Effect of fish age on predicted and observed chronic toxicity of lead to rainbow trout in Lake Ontario water. J. Great Lakes Res. 5: 84-89.

Hodson, P. V. "Factors affecting the sublethal toxicity of lead to fish." In Proceedings of the International Conference on Management and Control of Heavy Metals in the Environment. CEP Consultants Ltd., Edinburgh, U.K. pp. 135-138.

Hodson, P. V. Metering device for toxicants used in bioassays with aquatic organisms. Prog. Fish. Cult. 41: 129-131.

Hodson, P. V., U. Borgmann and H. Shear. "Toxicity of copper to aquatic biota." In Copper in the Environment, Part II. J. Nriagu (ed.), Wiley and Sons, New York. pp. 307-372.

Hodson, P. V., J. W. Hilton, B. R. Blunt and S. J. Slinger. Effects of dietary ascorbic acid on chronic lead toxicity to young trout (*Salmo gairdneri*). Can. J. Aquat. Sci. (in press).

Kelso, J. R. M. and C. K. Minns. Ecological implications of the once-through cooling process of thermal electric generation in Canada. Fisheries and Marine Service Manuscript Report No. 1482, 44 p.

Kelso, J. R. M. and J. K. Leslie. Entrainment of larval fish by the Douglas Point Generating Station, Lake Huron, in relation to seasonal succession and distribution. J. Fish. Res. Bd. Can. 36: 37-41.

Kelso, J. R. M. and G. S. Milburn. Entrainment and impingement of fish by power plants in the Great Lakes which use the once-through cooling process. J. Great Lakes Res. Vol. 5, No. 2.

Kozopas, R. and J. K. Leslie. Larval Fish Entrainment at Lambton Thermal Generating Station - 1978. CB-07015-8. January 1979.

Leslie, J. K., R. Kozopas and W. H. Hyatt. Considerations of entrainment of larval fish by a St. Clair River, Ontario, Power Plant. Fisheries and Marine Service Technical Report No. 868.

Millard, E. S., G. A. Burnison, C. C. Charlton, M. G. Johnson, R. Franks, and G. J. Sirons. Biomagnification of atrazine in lake column simulators. Report to the International Joint Commission, Windsor, Ontario. 27 p.

Millard, E. S., C. C. Charlton and G. A. Burnison. Availability of phosphorus in different sources entering the Great Lakes for algal growth. Report to the International Joint Commission, Windsor, Ontario. 38 p.

Minns, C. K. and M. G. Johnson. Temporal variation in the nutrient export of rivers draining into the Bay of Quinte, Ontario, Canada. Water Resources Bulletin 15: 1061-1072.

Munawar, M. and T. Bistricki. "Scanning electron microscopy of some nannoplankton cryptomonads." In Scanning Electron Microscopy/1979/III. SEM Inc., AMF O'Hare, IL 60666, U.S.A., pp. 247-260.

Munawar, M. and I. F. Munawar. A preliminary account of Lake Huron phytoplankton, April to December, 1979. Fisheries and Marine Service Technical Report (in press).

Munawar, M. and I. F. Munawar. The phytoplankton of Georgian Bay and North Channel, 1974: a preliminary study. Fisheries and Marine Service Technical Report (in press).

Munawar, M. A syntheses of Great Lakes algae on a lakewide basis. An invited contribution. The Canadian Botanical Association Bulletin (in press).

Niimi, A. J. Hexachlorobenzene (HCB) levels in Lake Ontario salmonids. Bull. Environ. Contam. Toxicol. 23: 20-24.

Niimi, A. J. Quantitative analysis of carbon-14 labelled polychlorinated biphenyls and hexachlorobenzene in biological samples using an oxidative combustion method. Inter. J. Environ. Anal. Chem. 6: 267-271.

Niimi, A. J. and G. A. Burnison. Recovery rates of ^{14}C-labelled polychlorinated biphenyls (PCB) in fish tissue using a combustion and a solubilization method of sample preparation for scintillation analysis. Bull. Environ. Contam. Toxicol. 23: 597-600.

Niimi, A. J. and S. L. Morgan. Morphometric examination of the gills of walleye (*Stizostedion vitreum vitreum*) and rainbow trout (*Salmo gairdneri*). J. Fish Biol. (in press).

Rao, S. S., R. E. Kwiatkowski and A. A. Jurkovic. Distribution of bacteria and chlorophyll a at a nearshore station in Lake Ontario. Hydrobiologia 66(1): 33-39.

Vallentyne, J. R. Road salt and the Great Lakes: an ecological lesson. Queen's Quarterly 86(3): 425-435.

Vanden Berg, C. M. G., P. T. S. Wong and Y. K. Chau. Measurement of complexing materials excreted from algae and their ability to ameliorate copper toxicity. J. Fish. Res. Bd. Can. 36: 901-905.

Watson, N. H. F. "Seasonal distribution of crustacean zooplankton in relation to physical factors." In Status of Biota of Lake Ontario, IFYGL. Biol. Chemical Final Report Vol. 3.

Williams, J. D. H., H. Shear and R. L. Thomas. Availability to *Scenedesmus quadricauda* of different forms of phosphorus in sedimentary materials from the Great Lakes. Limnology and Oceanography 25: 1-11.

Wong, P. T. S., P. V. Hodson, A. J. Niimi, V. Cairns and U. Borgmann (eds.). Proceedings of the Fifth Annual Aquatic Toxicity Workshop, November 7-9, 1978, Hamilton, Ontario. Fisheries and Marine Service Technical Report No. 862, 342 p.

Wong, P. T. S. and Y. K. Chau. "Methylation and toxicity of lead in the aquatic environment." In Proceedings of the International Conference on Management and Control of Heavy Metals in the Environment. CEP Consultants Ltd., Edinburgh, U.K., pp. 131-134.

Wong, P. T. S., G. Burnison and Y. K. Chau. Cadmium toxicity to freshwater algae. Bull. Environ. Contam. Toxicol. 23: 487-490.

Wong, P. T. S., C. I. Mayfield and Y. K. Chau. "Cadmium toxicity to phytoplankton and microorganisms. A review." In Biogeochemistry of Cadmium. J. O. Nriagu (ed.), Wiley and Sons, New York.

CENTRAL REGION

Staff List

T.D.W. McCULLOCH, A/DIRECTOR GENERAL

D. J. Cooper, Staff Assistant
R. Mikoda, Secretary

FINANCE & ADMINISTRATION SECTION

B.J.T. O'Hagan, Chief, Finance & Administration
A. White, Secretary

General Services Section: Head - M. Phillips

W. Mullan

Finance Section: Head - B. Davis

E.G. Mulvaney
E.F. Snead
K. Allan
B. Montani

Materiel Management Section: Head - E.R. Gibbons

R.J. Goodman
A.J. Desprey
L. Cardoza
D. Fox

Transport Co-ordinator: C.J. Fulton

PERSONNEL

I.D. Buzzelli, Regional Personnel Manager
F.E. Shandala, Assistant

Pay Clerks: B.J. Wydryk, P. Lindsay

SHIPS

A. Quirk, Regional Marine Superintendent
C. Dorion, Secretary

Operations:

W.S. Corkum
F. Haaka

CSS LIMNOS:

M.C. Birchall
J. Stansfield
L. Acker
G. Sproule
G. Wright
I.A. Williams
R. Farrell
G.F. Morrell
J.P. Dixon

CSS BAYFIELD:

F.R. Berchem
M. Trotter
R. Goreham
L. Hrabets
N.L. Keeping
S. Case

CSS ADVENT:

M. Head

SAR Relief Officers:

J. Cloutier
J. Wilhelm

On Base:

R. Gammon
R. Gay
E. Mott
D. Greenway

Engineering

A. T. Hughes

Boatshop:

K.D. Robertson
J. Fasullo
M. Ames
J. Barrowcliffe
W. Whaling

RESEARCH & DEVELOPMENT SECTION

N. G. Freeman, Chief, Research & Development
J. Fiddes, Secretary
S. Judge, Secretary

Shore Properties Studies:

W.S. Haras
R. Boyd
D. Sosnoski
G.L. Boyd
D. Canning
K. Weaver

Physical Oceanography:

S.J. Prinsenberg
L.R. Muir
G.S. Peck
W.P. Budgell

Biological Oceanography:

N.H.F. Watson*

Environmental Impact Assessment Officer:

J.R. Shaw

Program Support:

E.O. Lewis

Ocean Instrumentation:

S.D. Baird
D. Robertson

Oceanographic Operations:

D.J. Brooks
J. Anning
D. Moore

Computer Programming:

C. Doekes
P. Varga
R. Dawson
B. Flemming
G. Rogers

Survey Electronics:

W.W. Smith
R. Coons
H.J. Boyce
T. Dyas

HYDROGRAPHIC DIVISION

G.R. Douglas, Regional Hydrographer
R. Andrew, Secretary

E. Brown, Assistant Regional Hydrographer
V. Hamilton, Secretary

Hydrographic Development Group:

G. Macdonald
B.L. Tinney
N. Prince
P.G.M. Millette

Marine Information Centre:

A.R. Rogers
L. Mortimer

*On assignment from GLBL.

Hydrographic Data Centre:

A.R. Rogers
D. Robertson

Field Sheet Inspection Unit:

A.R. Rogers

Chart Production:

A.B. Thorson
C.J. Elliott
M.T. Frederick
C.R. Fisher
M.A. Lloyd
B.R. Beale
R.P. Warren
B.E. Richards
B. Little
D.B. MacKenzie
S. Chander
A.P. Gris
A.M. Bonnici
R.E. Chapeskie
H.C. Nepomuceno
S.G. Bockmaster

Tides and Water Levels Section:

B.J. Tait
R.R. Solvason
D.A. St. Jacques

Tidal Instrument Development Group:

B.J. Tait
J. Kozaczynski
J.H. Thurm
R.B. Johns

Hydrogaphers:

B.M. Wright
E.F. Thompson
R.A. Marshall
J.H. Wilson
R.J. Mahaffy
R.A. Covey
A.P. Welmers
P. Elliott
B. Eidsforth
J.G. Dixon
G.K. Thompson
J.J. Biggar
A.J. Koudys
J.H. Weller
G.P. Fenn
J. Medendorp
F. Hall
P.V. Davies
R.C. Lewis
K.J. Hipkin
M.J. Casey
C.V. Gorski
R.A. Langford
B.R. Power
M.R. Crutchlow
K.W. Daechsel
D.G. Pugh
R.K. Beri
R. Treciokas
M.L. Powell
M.P. Bennett
J.R. MacDougall
R.C. Robitaille

GREAT LAKES BIOLIMNOLOGY LABORATORY

R.L. Thomas, Director
E.A. Marshall, Secretary
J.R.W. Vallentyne, Senior Scientist

Administration:

J.K. Crescuolo
C.A. Fawcett
A.M. Vize

Surveillance:

H. Shear
L.R. Culp
D.M. Whittle
H.J. Nicholson
V.H. Cairns
J.D. Fitzsimons
R.E. Kwiatkowski
M. Munawar

Environmental Toxicology:

A.J. Niimi
P.V. Hodson
P.L. Luxon
O. Kramar
U. Borgman
P. Wong
C.C. Charlton
E.S. Millard
B.R. Blunt

Ecosystems:

J.M. Cooley
J.E. Moore
J.K. Leslie
C.A. Timmins
R.M. Dermott
W. Hyatt
N.H. Watson
C.K. Minns

Senior Scientist: M.G. Johnson

Sault Ste. Marie Office: J.R.M. Kelso
R.H. Collins
J.H. Lipsit
R.J. Love

Date Due
