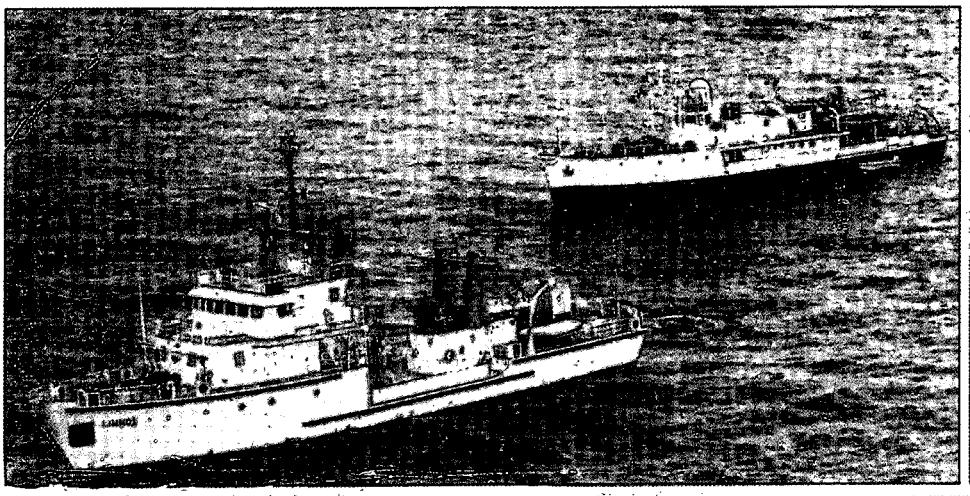
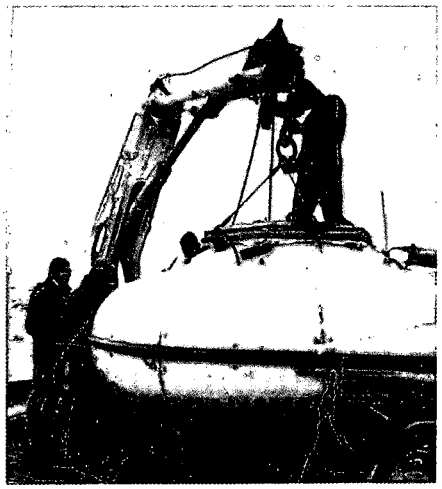
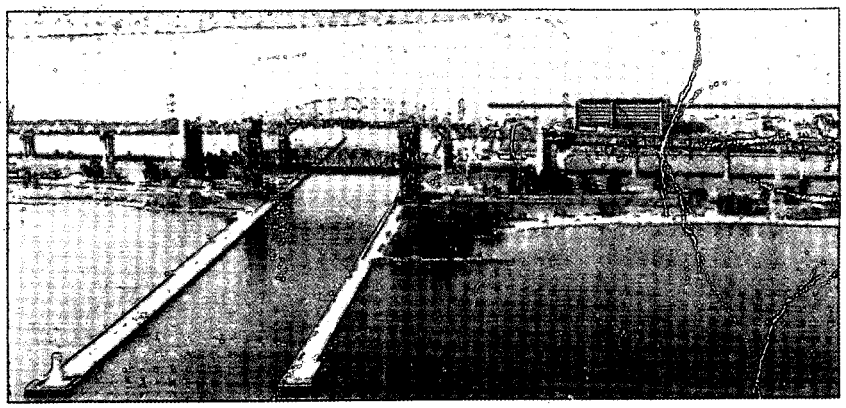
CANADA. OCEAN & AQUATIC Sciences. Central Region
ANNUAL REPORT

# 1980 ANNUAL REPORT





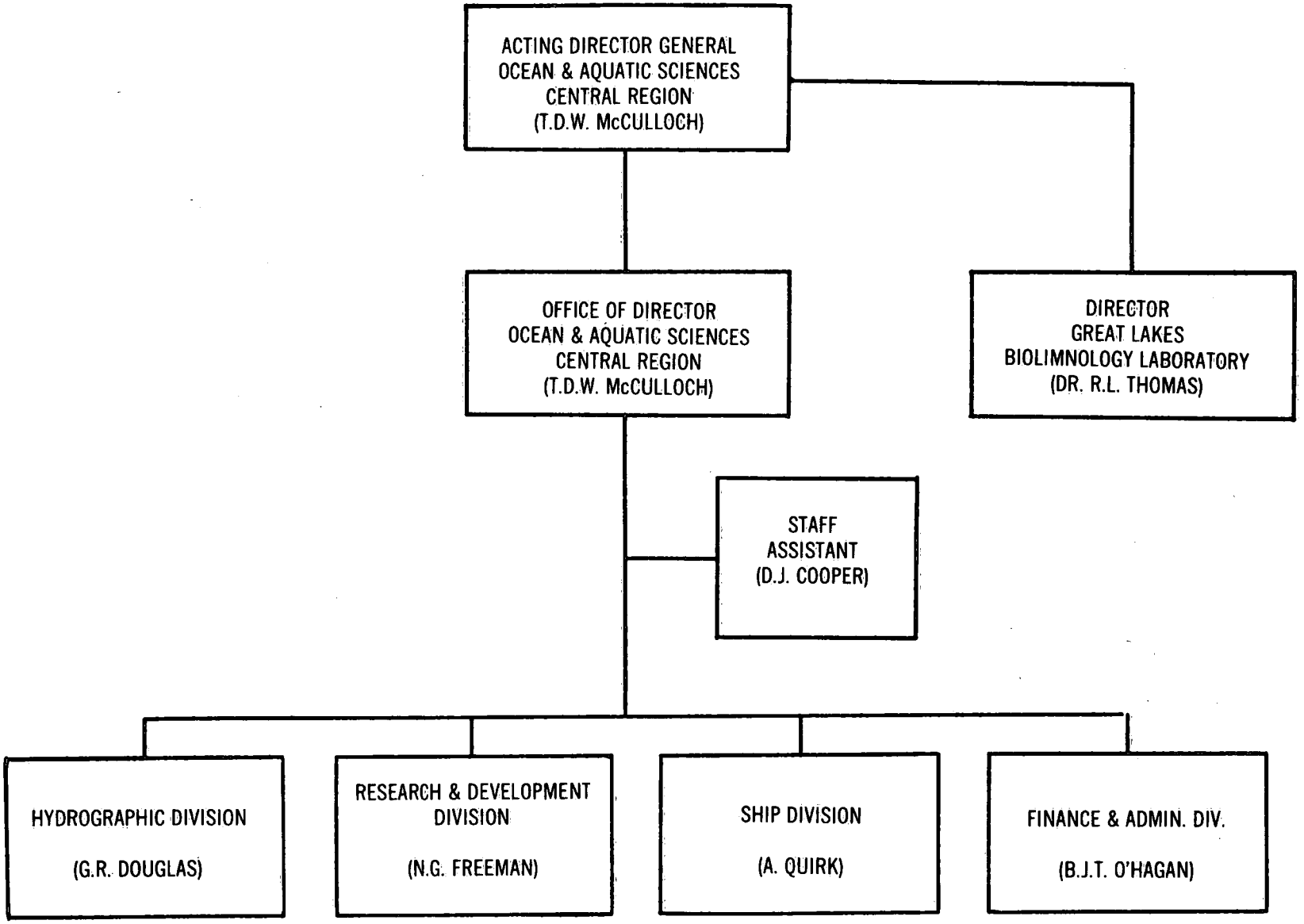


Ocean and Aquatic Sciences
Central Region
Fisheries and Oceans Canada
Burlington, Ontario

# 1980 ANNUAL REPORT

## Central Region
## Ocean and Aquatic Sciences
## Department of Fisheries and Oceans

# TABLE OF CONTENTS




**Sections**
Field Surveys
Hydrographic Data Centre
Marine Info. Centre
Hydrographic Dev.
Chart Production
Tides, Currents & Water Levels
Tidal Inst. Dev.

**Sections**
Physical Oceanography
Biological Oceanography
Shore Properties Studies
Ice Studies
Env'mtal Assessment/Ocean Info.
Program Support

**Sections**
Engineering
Marine Ops (Ships)
Marine Ops (Launches)
Marine Ops (Search & Rescue)

**Sections**
Financial Management
General Admin. Services
Fleet Management 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. 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 Acting Director General, Ocean and Aquatic Sciences for Ontario to the Assistant Deputy Minister, OAS. It consists of five divisions: Hydrographic, Research and Development (Oceanographic), Great Lakes Biolimnology Laboratory (GLBL), Ship, and Administration, with an allocated man-year total of 217 and a budget in excess of $10M. Additionally, the DFO Personnel Organization for Ontario reports to the Acting Director General, OAS.

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 Ship 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 (NWRI), the major occupant of Canada Centre for Inland Waters (CCIW).

The Great Lakes Biolimnology Laboratory based at CCIW continues for the present to belong with OAS, and this is reflected by the inclusion once again 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 interagency and interdepartmental 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. It is anticipated that GLBL will move to Pacific & Freshwater Fisheries shortly.

This was the third year of the Planning Review Evaluation (PRE) and coincidentally also the third year of a direct link between GLBL and OAS. The linkage was additionally strengthened by OAS membership on the Canada/Ontario Water Quality Agreement Working Group. The PREP exercise was completed by the end of the year, including the proposed targets for the Program Forecast Years to 1984-85.

The Arctic program was once more influenced to a large extent by factors beyond our control. The decision by MOT to leave CCGS NARWHAL on the west coast for an indefinite period caused further cancellation of the Hydrographic offshore Hudson Bay Program; the continuing budget cuts meant the forfeiture of a charter vessel for the inshore Hudson Bay surveys.

During 1980, the Region carried out hydrographic field surveys in M'Clintock Channel, central Lake Erie, the North Channel, Georgian Bay and the Bruce Peninsula of Lake Huron, Lake Nipissing and the St. Lawrence River. Additionally, revisory surveys were conducted throughout the Region from the Winnipeg River to the Ottawa River.

The Hydrographic Cartographic Unit increased its chart production substantially over last year with ten new charts being produced for the Ottawa River, Lake Erie and Hudson Bay. The automated cartographic Graphical On-Line Manipulation & Display System (GOMADS) was used to produce the Toronto Harbour chart and to document processing procedures.

The Hydrographic Development Section continued its ongoing work with GOMADS, the integrated Navigation & Data Acquisition System (NAVBOX) and the Marine Arctic Route Reconnaissance System (MARRS), and initiated two projects designed to improve data logging techniques. An Arctic Tidal Acquisition and Telemetry System (TATS) provided real-time water level data in M'Clintock Channel. Industry is developing a new submersible tide gauge under the direction of the Tidal Instrument Development Section.

Physical oceanographic research in the north is responding to information requirements for frontier oil and gas exploration and development, hydroelectric development, marine transportation, and the need for environmental assessments. On the Great Lakes, shore erosion studies are providing a better understanding of coastal geomorphological processes for the development of improved shore management policies.

Arctic oceanographic studies in the past have been aimed at describing circulation characteristics of interconnecting channels of the archipelago. Data from the 1979 survey of water structure and currents in the Sverdrup Basin and Viscount Melville Sound were published.

With the increased likelihood of tanker traffic in the Northwest Passage, however, emphasis is being shifted to developing a long-term measurement capability at a specific location (Barrow Strait). Data on under-ice current structure and water transport is being collected in order to assess inter-seasonal and inter-annual variability with special reference to their effects on, and how they will be affected by, Arctic marine transportation and resource development.

This continuing study, which is comprised of analyses of existing data, field measurements and theoretical development, is being coordinated with the Biological Oceanographic Program of the R&D Division, and the western and eastern Arctic studies of the Institute of Ocean Sciences and Bedford Institute of Oceanography.

Baseline conditions of salinity, temperature and currents are being determined, based on observations taken throughout Hudson Bay during the summer of 1975 and 1976. Because of large variations found in time and space in current and CTD data, meaningful average values are hard to define. This data was also used in the preparation of two papers on man-made changes in the freshwater input rates of Hudson Bay and James Bay and on the spatial and temporal variability of oceanographic parameters in Hudson Bay, as well as in an assessment of the environmental sensitivity of areas designated by EMR for oil and gas exploration activity.

Work continued on the development of analytical techniques to distinguish between the wind-driven components of the current and the mean circulation. Using a one-dimensional, wind-mixed layer model which included heat, mass and momentum surface fluxes, analysis of the wind effect on the vertical structure of the water column was started. Seasonal variation in the mixed layer depth was compared to available data, and effects on it due to hydroelectric developments were obtained for Hudson Bay and James Bay separately.

Arctic coastal inlets and fjords are ecologically sensitive areas which may be profoundly influenced by resource extraction (oil, gas, minerals, etc.).

At the present time, with the exception of a few isolated studies, the physics, chemistry and biology of Arctic inlets and fjords are virtually unknown.

Plans for the study of the physical oceanography of Arctic coastal inlets to relate the effects of physical processes upon nutrient and biomass distributions are underway. The study will provide baseline information on the circulation, tidal dynamics and heat budget of Arctic inlets and will be applied to environmental impact assessments.

The Freshwater Plume project is one component of a number of studies directed at understanding the effects on the marine environment of alterations in freshwater discharge brought about by hydroelectric construction on the La Grande River, James Bay.

It is anticipated that twelve times as much water as is discharged naturally will occur during the maximum winter power demand, resulting in a much deeper and broader freshwater plume under the ice.

Thus it is the specific objective of this project to examine the role of river discharge, ice cover, and tidal energy in the convection and dispersion of this additional freshwater in the Bay, through field measurements and numerical modelling of the freshwater plume dynamics.

A further objective, being carried out principally by the University of Guelph, Zoology Department, is to investigate the role of the freshwater plume in nutrient supply and biological productivity.

An oceanographic field program was carried out in February and March 1980 to measure changes in the distribution of physical and biological parameters in the La Grande River plume, under an increased post-project discharge of 3-4 times the natural flow. The plume approximately doubled in surface area and thickness over pre-project measurements carried out in 1975 and 1976. Vertical profiles of salinity, temperature and current at some twenty locations along and across the plume axis provided strong evidence of tidal control of mixing in the far field and river control in the near field. A vertically-integrated, one-dimensional, steady-state model reproduced the interface slope balance well, but required further refinement of the entrainment model to reproduce along-stream mixing. Work is also proceeding on a two-layer, tidally-averaged model to better represent mixing in the far field.

Preliminary results from the biological survey indicate that seston levels (POC & BIOC) reach maximum values in the near-field region of the plume (.1 to 1°/oo), indicating a riverine source. The distribution of silica, whose source is not riverine, indicates that, in the far field, bottom topography and tidal energy may be important by causing local physical suspension. Other nutrient phytoplankton populations and chlorophyll act relatively conservatively. Although the sea ice contains substantial levels of nutrients and particulates, it appears that the sea ice is not a significant source of either in mid-winter months.

The tidally-averaged, depth-density relationship and the current meter records collected from previous St. Lawrence River surveys were examined, and it was shown that both barotropic and baroclinic tides are important in the circulation of the estuary. In addition, the horizontal density gradients, while not affecting the propagation of the waves, do contaminate the observations considerably. In general, it is not possible to determine the wave field which gives rise to a particular set of measurements at a single location and, hence, it is necessary to make measurements synoptically.

Microzones (patches of zooplankton excretion products) have been thought to be important in providing for the nutrient requirements of marine phytoplankton in oligotrophic areas. However, these microzones are controlled by molecular diffusion and it has been shown that, even under the most favourable circumstances, these microzones will diffuse away too rapidly to be of any use to the phytoplankton. This work was done in conjunction with Dr. P.J.L. Williams of Southampton University.

This year marked the first complete year for a biological oceanographic program to be carried out under a secondment basis with Dr. N. Watson from the Great Lakes Biolimnology Laboratory.

Supervision of subvention and contracted work in Chesterfield Inlet and the La Grande River estuary resulted in the publication of the nutrient chemistry and biomass parameter data collected to date. Two MS theses on the phytoplankton and zooplankton of Chesterfield Inlet were also supervised, with their

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## CENTRAL REGION
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R. Mikoda, Secretary

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J.R.W. Vallentyne, Senior Scientist

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C.A. Fawcett
A.M. Vize

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M. Munawar

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O. Kramar
U. Borgman
P. Wong
C.C. Charlton
E.S. Millard
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C.A. Timmins
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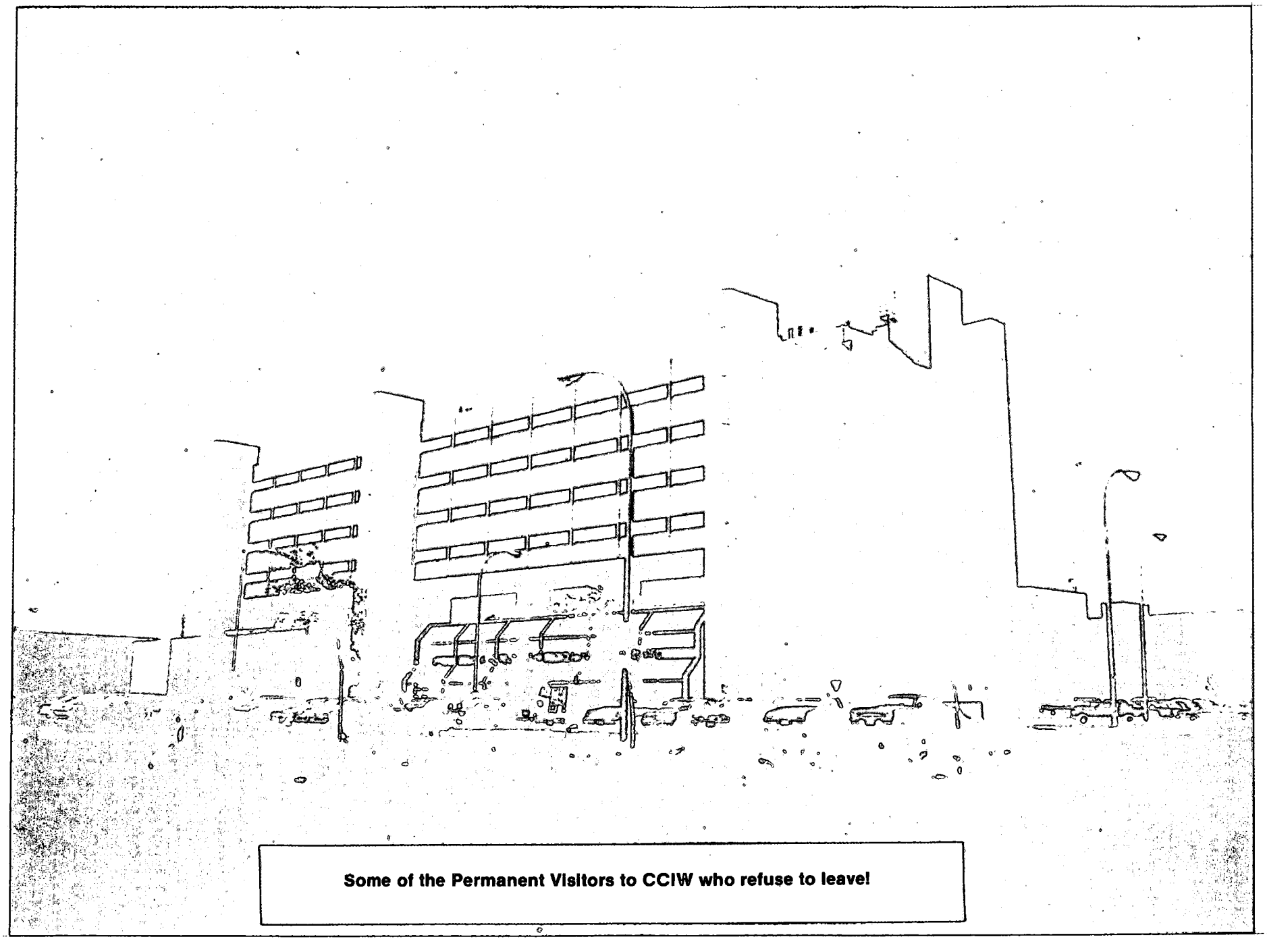
W. Hyatt
N.H. Watson
C.K. Minns

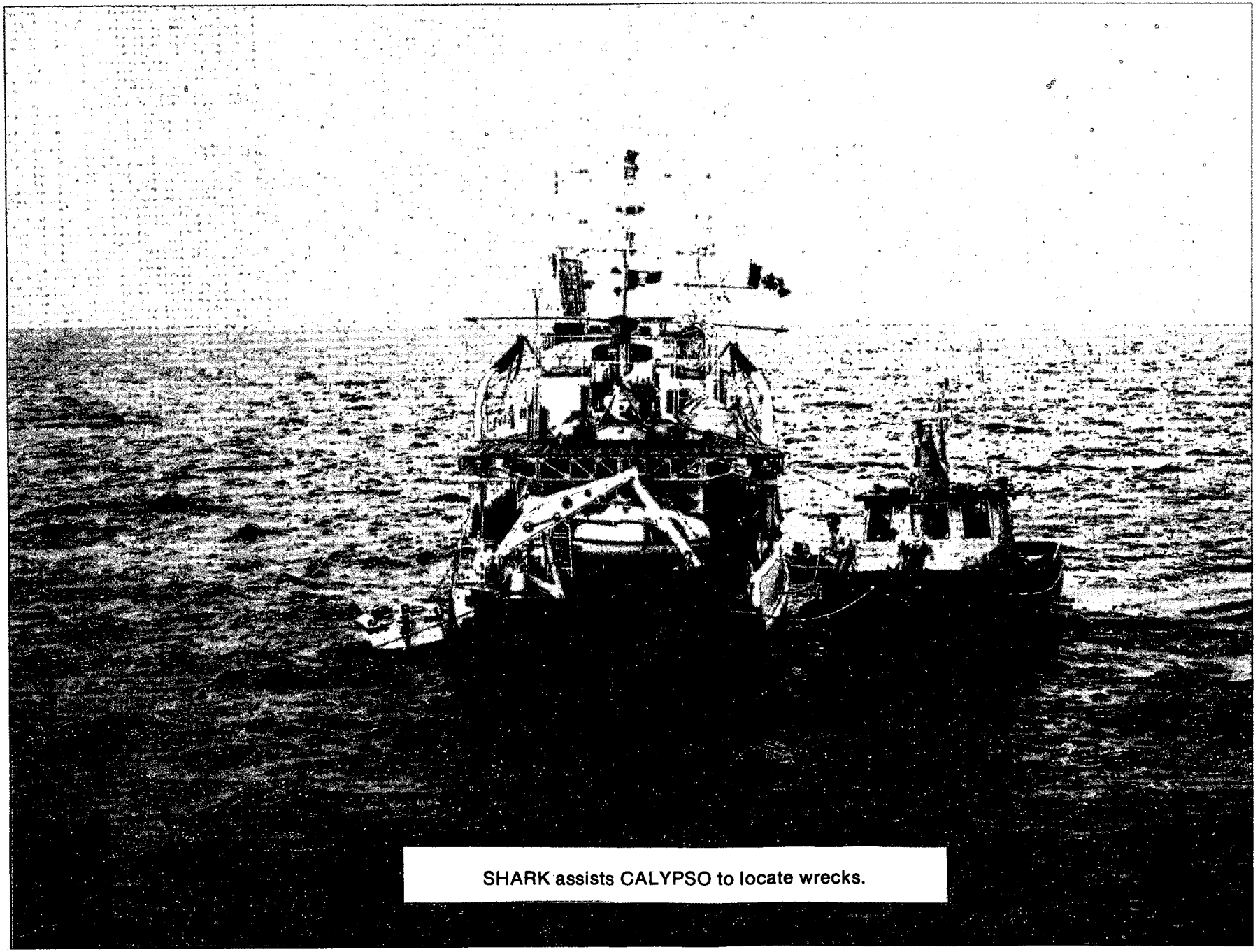
Senior Scientist:
Sault Ste. Marie Office
M.G. Johnson
J.R.M. Kelso
J.H. Lipsit
R.J. Love

*Left during 1980
+Deceased



**Some of the Permanent Visitors to CCIW who refuse to leave!**

C.S.S. LIMNOS assists R.V. CALYPSO to position over wrecks of U.S. warships HAMILTON and SCOURGE sunk in the war of 1812 off St. Catharines, Ontario.



SHARK assists CALYPSO to locate wrecks.

completion expected in February of 1981.

Under the aegis of a Canada/Ontario Agreement, stage-related onshore and offshore erosion profile data are collected at 162 sites to develop a better understanding of erosion processes in the Great Lakes system.

An Interim Report was prepared documenting short-term erosion rates needed in establishing building setback calculations and shoreland planning. The Report also provides some insight into the complex interaction of geomorphological processes for the Great Lakes glacial physiographic regions generally, and as it relates to individual sites specifically.

The optimum time to calculate representative short-term bluff erosion rates has been found to be when the bluff returns to its original profile. These representative rates define the high water level sediment transport budget for the shore system.

No correlation between beach changes and water levels has been identified, probably because the water levels have not yet subsided sufficiently. However, by grouping the nearshore profiles using morphological and compositional criteria and subsequently correlating them to onshore observations, meaningful distinctions have been made concerning the causes, rates and modes of erosion not otherwise possible using onshore observations only.

Four estuaries on James Bay are being monitored annually to record baseline erosion information. Field surveys are undertaken at the Albany and Attawapiskat Rivers on the west side of the Bay, and at the Eastmain and La Grande Rivers on the east side of the Bay. Information collected includes river bank profiles, stratigraphic samples and photographic documentation.

The main effort on the Sea Ice Radar project is concentrated on understanding the electrical characteristics of ice and the physics of the radar signal for the design of remotely-mounted radar systems to delineate ice conditions for navigation, research and information required in the event of a marine accident. A contract was issued to McMaster University to evaluate the existing knowledge of the electrical properties of sea ice and its interaction with radar signals. Preparations are underway for field investigations to be carried out on Borden Peninsula during the Arctic oceanographic survey in the spring of 1981.

Work also commenced on the development of a portable ice physics laboratory for Arctic sea ice studies and a long-term ice physics measurement program in the Northwest Passage. The laboratory is designed to contain all equipment necessary to undertake measurements of the physical and electrical properties of sea ice and will include the development of a standard procedures manual for the use of equipment. Evaluation tests are planned during the Arctic oceanographic program in FY 81 in Eclipse Sound.

Studies conducted by GLBL in 1980 reflected continued support of the 1978 revised Great Lakes Water Quality Agreement. In addition, two new studies were initiated reflecting concern for the impact of contaminants on biota.

The first program was fish health assessment comprising a survey of tumors in Great Lakes fish and a study of the incidence of malformed male lobe trout zonads. These studies were designed to elucidate the impact of environmental stress on populations of fish.

The second new program was the Aquatic Effects of Long Range Transport of Atmospheric Contaminants study, being carried out at the Turkey Lake Forest Watershed (in Algoma), selected sensitive inland lakes and selected embayments along Georgian Bay — North Channel.

The year 1980 saw the opening of GLBL's second satellite laboratory at Owen Sound, run by Dr. M.G. Johnson. Work in this laboratory is directed towards limnological studies in Lake Huron and Georgian Bay, with special emphasis on the effects of acid rain on embayments in western and northern Georgian Bay. Dr. M.G. Johnson will be conducting the Lake Huron program from there.

Dr. J.R. Vallentyne, Senior Scientist, Fisheries and Oceans, with Dr. J.R. Strickler of Australia and Prof. Nichols Polunin of Geneva, proposed global adoption of a World Decade of the Biosphere to improve public, scientific and political focus on measures for safeguarding our Biosphere. Symbolizing this need with a 30-centimetre globe on his back, Dr. Vallentyne transmitted the message to newspaper and television audiences numbering in the millions in Canada, Japan, Denmark and the United States. The Decade proposal has been accepted and will be coordinated by the World Environment and Resources Council.

Dr. Vallentyne retired as President (1974-80) of the International Association of Limnology, presiding at its XXI Congress in Kyoto, Japan. In 1980 he was elected chairman of the Rawson Academy, a newly-established organization with broad interests focussed on wise management of Canadian water resources.

A major contribution made by GLBL was the development of the Strategic Great Lakes Fisheries Management Plan for the Great Lakes Fishery Commission.

## HIGHLIGHTS

The Search and Rescue programme continued successfully in 1980. Many SAR incidents were recorded, including one particularly harrowing case in the North Channel when NAUTILUS rescued one person who had been in the water for seventeen hours.

A new vessel, CSL SHARK, was acquired. She is constructed of all welded steel, built to a design proven to be successful and popular with the U.S. Army Corps of Engineers, who have many similar craft in service.

The Cousteau Society research ship CALYPSO docked at CCIW and worked in western Lake Ontario on two different occasions. The purpose of the visits was to film the sunken 1812 U.S. Warships HAMILTON and SCOURGE. CSL SHARK played a major role by positioning CALYPSO over HAMILTON and providing considerable assistance in the enterprise. A helicopter also supported the programme by transporting personnel and equipment.

Eleven of the Region's hydrographers are enrolled in a survey law course sponsored by the Canadian Institute of Surveying. The survey law course is part of the curriculum for the newly-established Canada Lands Surveyor programme.

The NOS ship WHITING, Commander Rossi, and the Ship's complement of hydrographers and crew visited the Region in October. Her visit coincided with the fall meeting of the Great Lakes Charting Advisors Committee, with Rear Admiral Houlder, Commanding Officer of the Atlantic Marine Centre, heading the U.S. Delegation.

The Toronto Boat Show exhibit was a great success, particularly as two hydrographers had devised an "Order of the Bent Prop", which was awarded to members of the public who participated.

The Regional Hydrographer attended the Oceanology Conference in Brighton, England, as part of an Industry, Trade and Commerce project promoting Canadian Hydrographic and Oceanographic Surveying Industries.

In July, the A/DG represented Canada at the FIG Permanent Committee meeting in Edinburgh, Scotland. In addition, as Chairman of Commission Four, he presented the Commission Annual Report to the Permanent Committee, advising them of Working Group and Advisory Board progress and of the Commission's plans for the 1981 FIG (International Federation of Surveyors) Congress to be held in Montreux, Switzerland. He and his family were honoured by an invitation from Rear Admiral Haslam, Hydrographer of the Royal Navy, to a dinner party on HMS HERALD, attended by Vice-Admiral Sir Thomas Baird, RN, Flag Officer, Scottish Waters, Lady Baird and Rear Admiral Ritchie (RN Ret.), President of the Directing Committee of the International Hydrographic Organization. Later, at Rear Admiral Haslam's invitation, an official visit on behalf of FIG was made to the RN Hydrographic Department headquarters in Taunton. At the request of the Irish Government, a visit was made to Dublin to discuss Ireland's hydrographic problems.

Other events of importance were the visit of Mr. R. Steel, Secretary of the Commonwealth Association of Surveying and Land Economy (CASLE) in connection with the CASLE/81 Congress to be held in Ottawa in September, 1981; the visit of the Regional Marine Superintendent to United Kingdom Shipbuilders in May; and the OAS Senior Management meeting, chaired by the ADM in Burlington. The International Hydrography Committee, with joint IT&C/DFO backing, and chaired by the A/DG, achieved a number of firsts in 1980. A monthly information sheet, containing information on overseas projects of interest to the Canadian Hydrographic and Oceanographic Industry was established and disseminated. Visits to a number of overseas countries underlined Canadian opportunities. One result of all this activity was the announcement of the formation of CAHOSI (Canadian Association of Hydrographic and Oceanographic Surveying Industries) in December, 1980.

The A/DG attended the CASLE Pacific regional meeting in Papua, New Guinea, during the first week of September. While there he presented a paper on "The Exploitation, Management and Development of Oceanic Resources," and took part in the other sessions of the regional meeting, including the Executive Committee and the Commonwealth Board of Surveying Education. Contacts were made with officials of the PNG government on hydrographic matters, including an interview with the Deputy Prime Minister. Later, visits were made to Malaysia and Hong Kong in pursuit of International Hydrography Committee objectives.

As in past years, a sincere thank-you to Finance and Administration for keeping us on track in 1980, to the secretaries whom we rely upon so much, and to my Staff Assistant for a competent job of compiling and editing this report.

## HYDROGRAPHIC DIVISION

### Introduction

Operating from the Canada Centre for Inland Waters in Burlington, Ontario, the Central Region of the Canadian Hydrographic Service is responsible for charting the navigable waters of Manitoba and Ontario, including Hudson Bay. In addition, the Region also collects hydrographic and tidal data in the Canadian Arctic Archipelago.

During 1980, the Region dispatched field parties to M'Clintock Channel in the Arctic Islands, to central Lake Erie, to the North Channel, Georgian Bay and the Bruce Peninsula of Lake Huron, to Lake Nipissing and to the St. Lawrence River. In addition, Revisory surveys were conducted throughout the Region from the Winnipeg River to the Ottawa River, and rotational hydrographers charted the approaches to Nanticoke Harbour on Lake Erie.

The field surveys produced several noteworthy accomplishments this year. The M'Clintock Channel and the North Channel surveys successfully used solar panels to extend battery life on Mini Ranger III chains. The North Channel Survey also extracted shoreline and inshore contours from aerial bathymetry plots provided by Hunter and Associates. Laser measuring units were used for horizontal control for harbour surveys in Georgian Bay and the St. Lawrence River.

The Cartographic Unit increased its chart production substantially over last year. A total of 10 new charts were produced for the Ottawa River, Lake Erie and Hudson Bay. In addition, two cartographers were assigned to the automated cartographic system, GOMADS, to produce the Toronto Harbour chart and to document the processing procedures.

The Hydrographic Development Section continued its ongoing work with GOMADS, NAVBOX and MARRS. At the same time, the Section initiated two projects designed to improve data-logging techniques.

The Tides, Currents and Water Levels Section conducted a tidal survey of M'Clintock Channel in conjunction with the Central Region hydrographic survey of the area. During this survey, an Arctic TATS was installed near the hydrographic base camp and provided real-time water levels. D.G. Instruments, Ottawa, are developing a new submersible tide gauge on behalf of the Tidal Instrument Development Section.

G. Thompson and J. Dixon prepared the CHS exhibit for the Toronto Boat Show. The highlight was the "Order of the Bent Prop," which was awarded to members of the public who participated in a questionnaire based on the CHS display.

In October, eleven of the Region's hydrographers attended a survey law course sponsored by the Canadian Institute of Surveying, in preparation for the 1981 Canada Lands Surveyor examinations.

The NOAA ship, WHITING, and her complement of hydrographers and crew visited the Region in October. Her visit coincided with the fall meeting of the Great Lakes Charting Advisors Committee.

During the year the Region lost the services of R. Chapeskie, F. Hall, R. Lewis and B. Tait. Ray Chapeskie accepted a supervisor's position in the Pacific Region, and Frank Hall joined the College of Trades and Technology in St. John's, Newfoundland, as Head of the Survey Department. Reg Lewis became the Manager of Hydrographic Planning and Records with the Atlantic Region, and Brian Tait is the new Chief of Tides, Currents and Water Levels at Headquarters, Ottawa.

B. White joined the Region as Head of the Tidal Instrument Development Section.

### Field Hydrography

The areas where hydrographic surveys were conducted by Central Region in 1980 are shown on Figures 1 and 2. Table 1 gives details of survey vessels, positioning systems and processing techniques.

*Winter Survey*

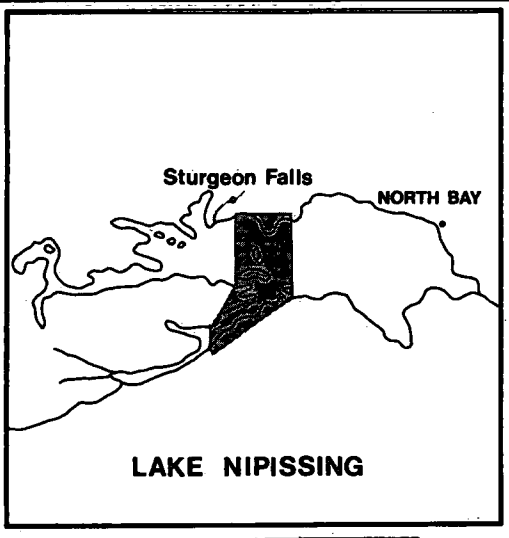
With support from the Polar Continental Shelf Project of the Department of Energy, Mines and Resources (DEMR), P. Davies' party carried out a detailed through-the-ice survey of northern M'Clintock Channel and Guillemard Bay. In M'Clintock Channel, the survey operated in conjunction with the Earth Physics Branch of DEMR who collected gravity observations and soundings throughout the Channel on a 6-km grid. For hydrographic purposes, the grid was reduced to 2 km from the shoreline to the 200-metre contour on both sides of the Channel. Electric rams were installed on two of the helicopters and on the tracked vehicle and provided more than half the soundings. Solar panels were used successfully during the tracked vehicle survey of Guillemard Bay to extend battery life for the Mini Ranger III positioning system (Fig. 3). The survey produced a total of 22,383 spot soundings in an area of approximately 10,000 square miles.

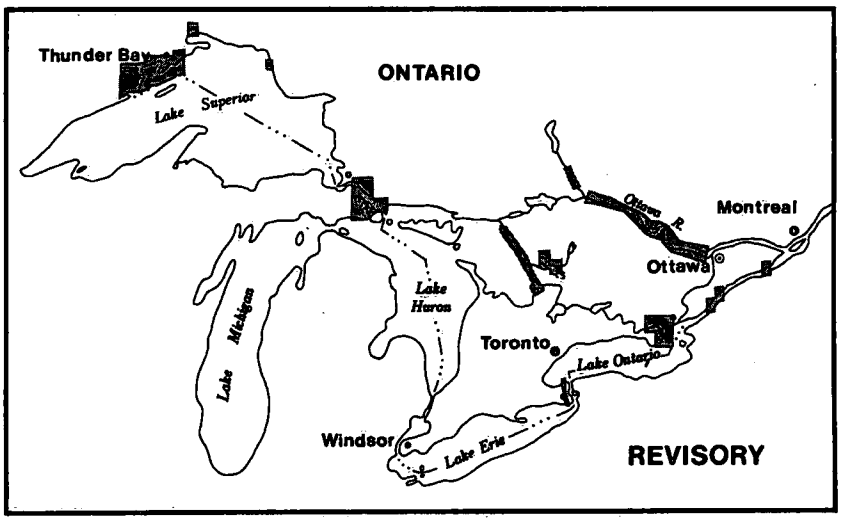
The survey camp, situated on the west side of Prince of Wales Island, was left on site over the summer months and will be used at the same location for the 1981 survey.

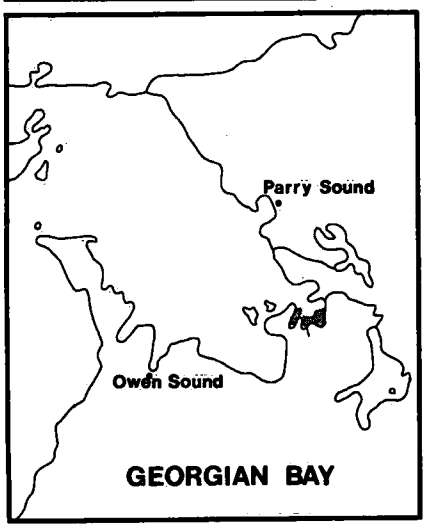
*Summer Surveys*

During the summer of 1980 productive hydrographic surveys were carried out in the North Channel of Lake Huron, Georgian Bay, Lake Erie, the St. Lawrence River and Lake Nipissing. However, a high priority survey in Hudson Bay was postponed once again because of the lack of ship support.

In the North Channel of Lake Huron, R. Marshall's survey party used two Nelson 34 launches, NAUTILUS and NIMBUS, to conduct a detailed survey of the area from Mississagi Island westward to Thessalon Island. Automated logging and processing (INDAPS) and manual techniques were combined

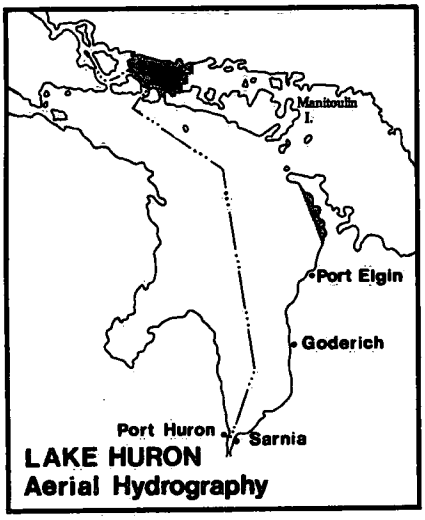


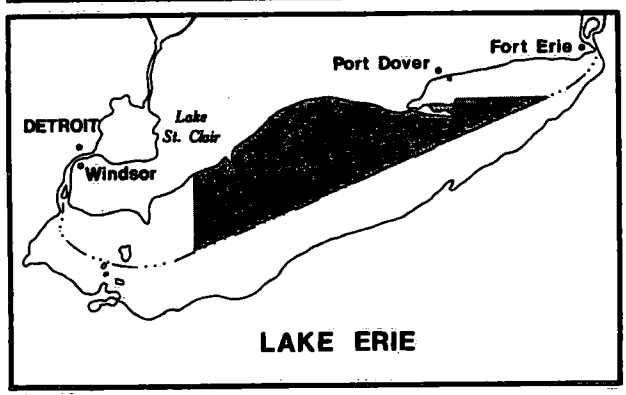




# CENTRAL REGION
# 1980
# HYDROGRAPHIC SURVEY PROGRAM
## (Eastern and Southern Areas)

Area Surveyed

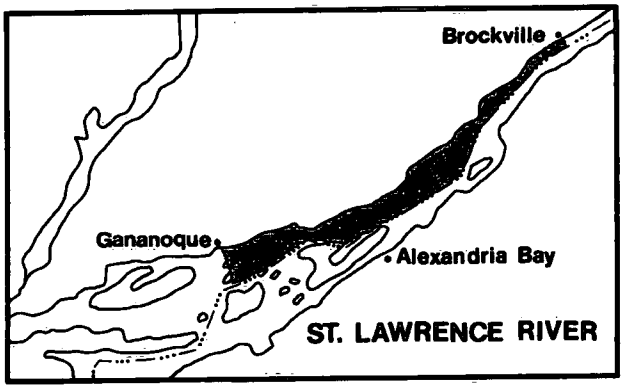




Figure 1

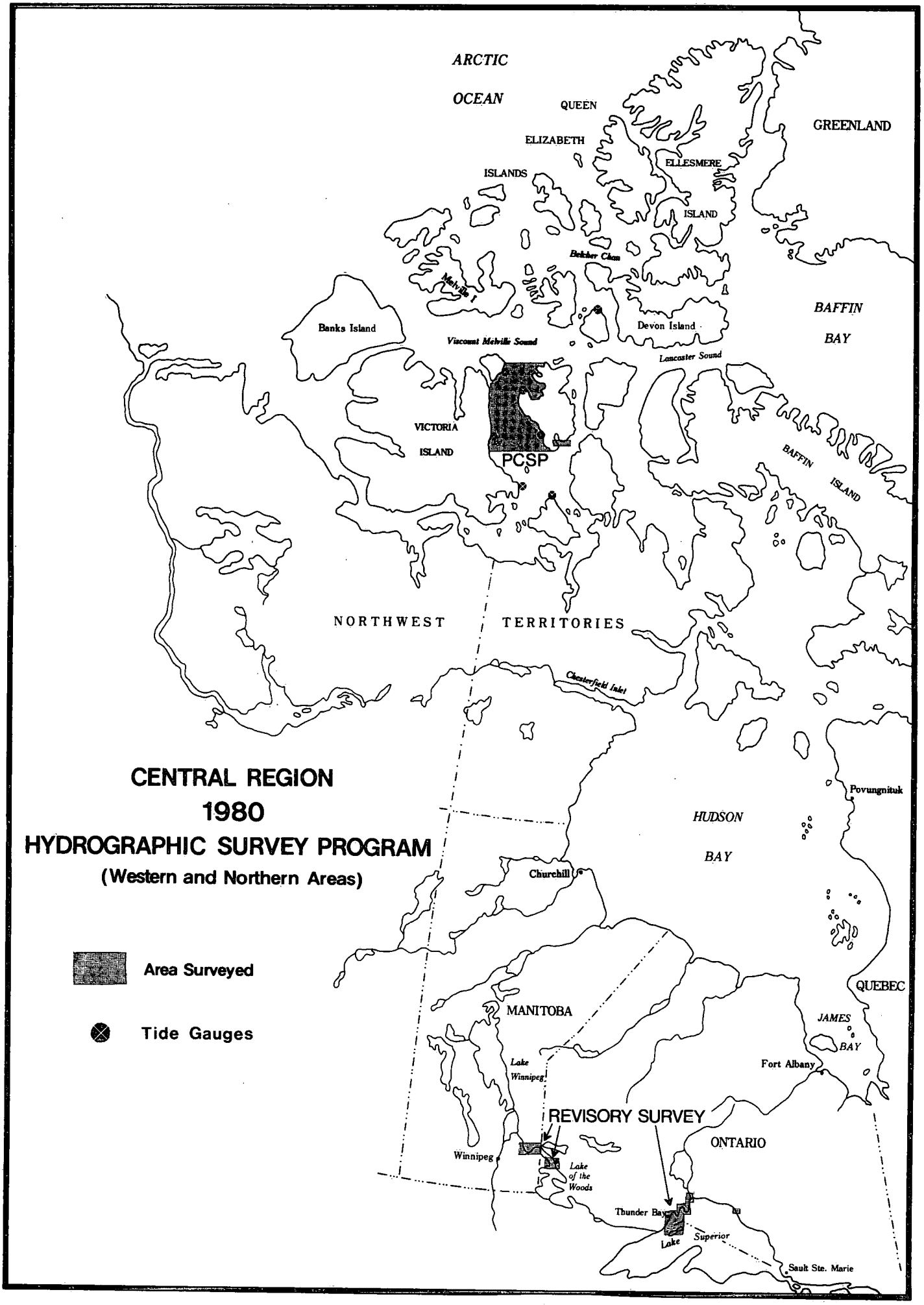

ARCTIC
OCEAN
QUEEN
ELIZABETH
ISLANDS
ELLESMERE
ISLAND
GREENLAND
Bekker Chan
Melville I.
BAFFIN
BAY
Banks Island
Viscount Melville Sound
Devon Island
Lancaster Sound
VICTORIA
ISLAND
PCSP
BAFFIN
ISLAND
NORTHWEST
TERRITORIES
Chesterfield Inlet
CENTRAL REGION
1980
HYDROGRAPHIC SURVEY PROGRAM
(Western and Northern Areas)
Area Surveyed
Tide Gauges
Povungnituk
HUDSON
BAY
Churchill
QUEBEC
MANITOBA
JAMES
BAY
Lake
Winnipeg
Fort Albany
REVISORY SURVEY
ONTARIO
Winnipeg
Lake
of the
Woods
Thunder Bay
Lake
Superior
Sault Ste. Marie



Figure 2

MONK POINT
NORTH CHANNEL
LAKE HURON / GEORGIAN BAY
SHALLOW WATER BATHYMETRY
CANADIAN HYDROGRAPHIC SERVICE
HUNTER AND ASSOCIATES
TORONTO
ST. JOHN'S
SCALE 1:30,000 METRES
0 500 1,000 1,500
2

Figure 4.

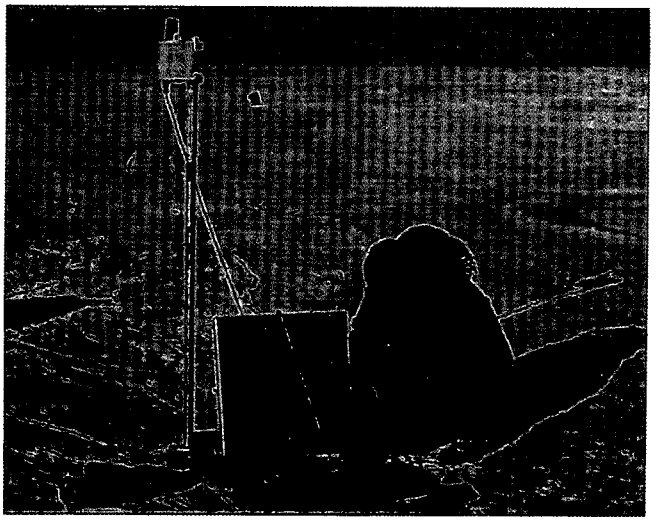


Figure 3. Mini Ranger Solar Powered Positioning System

to collect the sounding data. The survey was also the first to make extensive use of aerial bathymetry plots (Fig. 4) for establishing shoreline and inshore contours.

In southeastern Georgian Bay, A. Welmers headed the harbour surveys of Midland, Tiffin, Penetanguishene, Port McNicoll and Victoria Harbour. These surveys will lead to the production of a new type of harbour chart where each harbour will be on a separate chart and other unique features will be incorporated. Our new Laser Ranger V was used extensively during this survey and all users reported complete satisfaction with its capabilities.

The Lake Erie survey, under the direction of F. Hall and P. Davies, progressed eastward from Plum Point to Long Point during 1980. The BAYFIELD, a Bertram and a Hydro were used to complete the coastal and offshore surveys of the lake. The harbours remain to be surveyed. As in 1979, the limnogeology lines were ignored and the entire area was resurveyed. Some shoals were found in the inshore area but the offshore is very flat.

The St. Lawrence River survey, led by R. Lewis, moved downriver from the area that was surveyed in 1979. In 1980, the area from Rockport to Brockville was completed at a scale of 1:10,000. In addition, Brockville Narrows was surveyed at a scale of 1:5,000 and Brockville Harbour at 1:1,000. The shoreline for Brockville Harbour was developed using a TopCon Laser unit (Fig. 5). At year's end two of these units were purchased.

During the second year of a multiyear program in Lake Nipissing, E. Thompson's survey party covered the area from Jocko Point to west of Sandy Island. The topography of the western end of this lake is more complex than the east end, and, therefore, required more time to survey. A helicopter was used extensively on this survey to bomb shoals and fix rocks in the shallow waters of this lake (Fig. 6).

Once again, the Revisory Survey covered most of the southern limits of the Region. M. Crutchlow's group spent most of the time working on charts of the Winnipeg River, Lake of the Woods, Thunder

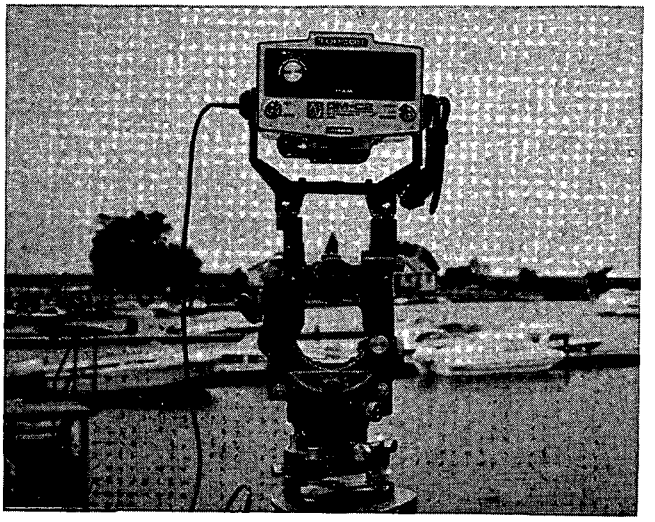


Figure 5. TopCon Laser Unit.

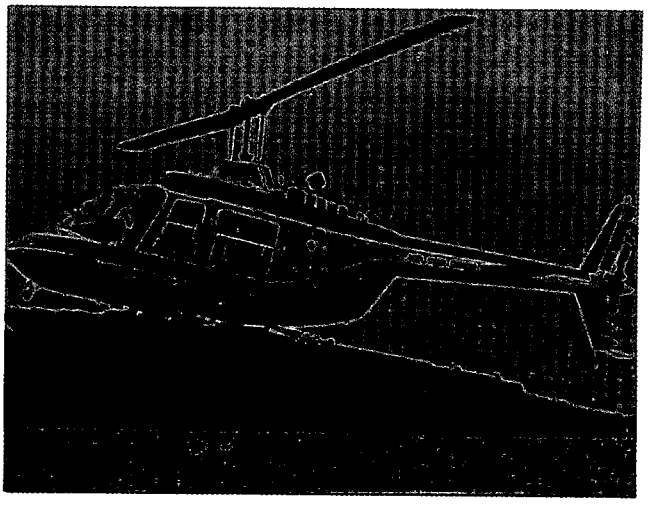


Figure 6. Bombing Shoals

Bay, Georgian Bay, Ottawa River and the St. Lawrence River. Considerable time and effort was spent collecting data for the Winnipeg River charts because the area has never been properly surveyed. Ideally, the River, from the Ontario-Manitoba border to Lake Winnipeg, should be surveyed to modern standards.

The U.S.-Canada exchange program continued in 1980 with G. Fenn participating from Canada and S. Bradford from the U.S. The exchange program continues to be an excellent means of keeping in touch with U.S. programs and survey procedures.

The BAYFIELD was used to calibrate the Loran-C in Lake Huron. The Headquarters Nautical Geodesy Section provided considerable input in the planning of this program and one man to participate in the field work.

During 1980, R. MacDougall worked closely with the Canada Centre for Remote Sensing on all phases of the Aerial Hydrography Project. Central Region's effort was concentrated on the field work required for the Bruce Peninsula project.

In eastern Lake Erie, rotational hydrographers under J. Wilson conducted a survey of Nanticoke Harbour and approaches. The survey operated out of the Burlington Office.

R. Langford spent the summer in Quebec Region in charge of surveying many of the harbours along the Lower St. Lawrence River.

**Hydrographic Data Centre**

The benefits from previous refinements to data handling in the HDC were apparent this year with a 30% increase in the number of new documents processed. A total of 1211 individual items were filed for chart production use, including 68 field sheets and 257 historical records from Ottawa. Documents are now referenced to all applicable charts rather than to only the largest scale chart as in the past.

Thirty-seven requests for aerial photographs resulted in orders for 1612 prints during the year.

Routine use of the DEMR Data Bank has improved both turnaround time and the quality of horizontal control information available to survey parties. A manual to help users interpret the printout was prepared.

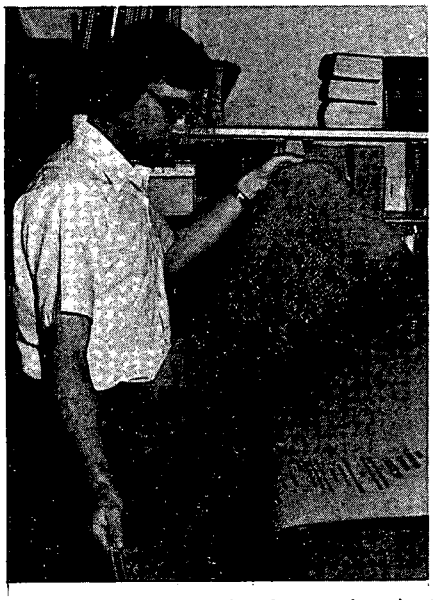


Fig. 7. Retrieval of Information in the Hydrographic Data Centre

Innovations during the year include a Central Region "Correspondence Reference Numbers" system to help the compilation section keep track of correspondence of significance to chart compilation, and a new system to record HDC Library loans (Fig. 7). The slide library has now been fully indexed and a system established to keep track of loans.

**Marine Information Centre**

Local sales of charts, topographical maps, and various publications rose to record high levels this year. A total of 1,460 members of the general public visited the MIC in 1980 and purchased 1,500 charts, 1,640 topographic maps, and 315 other publications, including List of Lights, Radio Aids and Chart No. 1. There are 730 editions of Canadian charts, 60 marine publications, topographic maps, and special purpose maps, and about 55 general information brochures and pamphlets presently in stock and available to the general public and departmental staff.

**Hydrographic Development**

The main responsibility of the Hydrographic Development Section is to investigate and evaluate new equipment and techniques for both hydrographic and cartographic applications. In addition, the Section provides support for computer-assisted data processing. Although the Section has remained actively involved with GOMADS, NAVBOX and MARRS this year, it has initiated a major effort towards solving the problems associated with data logging.

*Graphical Online Manipulation and Display System (GOMADS)*

The computer-assisted cartographic station became completely operational early in the year. The station consists of the GOMADS interactive editor and software library on the PDP-11/34 computer, and a Gradicon digitizer on the PDP-8/E computer. Two cartographers are evaluating the performance of both the hardware and software and documenting the operational procedures so that the system can be used in a production environment.

*Navbox*

Eleven NAVBOX units, including seven production units from D.G. Instruments, were used during the 1980 field season. A NAVBOX training course was given to Central Region hydrographers prior to the field season, and field training for operators was also provided in the Quebec Region. Hardware support continued through the field season. Software development included the provisions to fix on distance as well as time, to print navigational parameters, and to calculate UTM scale factor.

*Data Loggers*

One of the primary aims of the Section in 1980 was to develop a reliable method of logging digital data. Two approaches were attempted. First, a new cassette data recorder incorporating an MFE Model 450-B tape transport was designed and constructed. Four prototypes will be tested in Atlantic and Central Regions next year. Second, a contract was awarded to TES Limited of Ottawa to develop and build two prototype microprocessor-based data storage units. The units will contain two INTEL magnetic bubble memory boards with a Mega-byte of non-volatile storage and no moving parts. The BUBBLEBOX will be interchangeable with the cassette recorder when interfaced with NAVBOX.

*Marine Arctic Route Reconnaissance System (MARRS)*

Following the Bedford Basin tests of the prototype Marine Arctic Route Reconnaissance System (MARRS) by Marinav Corporation in 1979, the system was turned over to Central Region. The data

collected during the field test were reprocessed in 1980 for re-evaluation by CHS personnel. Data processing software and a transducer deployment unit were developed for 1981 Arctic field trials.

*Mini Ranger III*

A project to determine the effect of signal strength on Mini Ranger III accuracy was conducted on Lake Erie this summer. A NAVBOX was modified to print signal strength readings. Results of the tests will be presented at the upcoming Canadian Hydrographic Conference in Burlington.

*Data Processing*

The Gerber-22 plotter and PDP-8/1 computer were kept busy drawing field sheet base plots, lattices, field sheet titles and sounding plots in support of field surveys. Special cartographic projects were also plotted.

Hydrographers are using the PDP-11/34 computer and the Calcomp 960 plotter to run interactive survey computation programs and to produce rough plots of field sheet titles and soundings. A remote, dial-in line has been added to the PDP-11/34 so that hydrographers can access the survey programs directly from the field. A colour-coded option for the sounding plot program was introduced which permits soundings within a specified depth range to be plotted in a particular colour. Since six colours are available, it is possible to select six depth ranges. The plots are used to check for data errors and to assist with contouring.

An 8085 cross-assembler and PROLOG PROM burner have been installed on the PDP-11/34 and are being used for cassette recorder and NAVBOX software development.

*Other Projects*

A prototype Precise Radar Navigation System (PRANS) (Fig. 8), developed for Transport Canada and the Dominion Marine Association, was tested on the St. Lawrence Seaway near Prescott. A tellurometer MRD-1, operated by Central Region staff, provided the horizontal control for the PRANS reflector sites and dynamic positions for the launch during the accuracy tests.

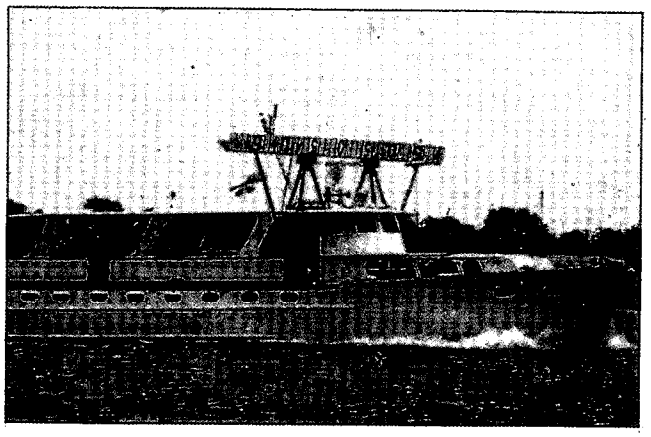


Figure 8. Evaluating PRANS

Table 1. Summary of 1980 Central Region Field Survey Program

| Survey Area | Vessels | Positioning System | Field Data |
|---|---|---|---|
| PCSP | 4 206B Helicopters<br>1 Tracked Vehicle | Decca<br>MRS 111<br>NAVBOX | Manual |
| Lake Nipissing | 2 Botveds<br>1 MonArk | MRS 111<br>NAVBOX<br>Hydrodist | Manual |
| Lake Huron (North Channel) | NIMBUS<br>NAUTILUS | MRS 111<br>NAVBOX<br>Hydrodist | INDAPS and Manual |
| Lake Erie | BAYFIELD<br>1 Bertram<br>1 Hydro | MRS 111<br>NAVBOX | Manual |
| Georgian Bay Harbours | 1 MonArk | Hydrodist | Manual |
| St. Lawrence River | 4 Botveds | MRS 111<br>Hydrodist | Manual |
| Revisory | LFGB 2 | MRS 111 | Manual |

Software support and an operator's training course were provided for INDAPS users.

A discussion paper on sounding selection methods and data archiving was prepared for the Planning and Development Section at Headquarters.

**Chart Production**

The year proved to be productive for the Cartographic Unit in Central Region. The Unit worked hand-in-hand with the hydrographic survey parties and shared in their positive outlook. Similarly, hydrographers became more aware of the cartographer's perspective of the charting business and recognized the innumerable items that field sheet production does not resolve. In addition, closer cooperation with the Region's vertical datum group (Tides, Currents and Water Levels Section) has assisted the Cartographic Unit with making comparisons and resolving questions with regard to clearances, high water determinations, and hydrographs.

The reprographic unit, under the able leadership of D. MacKenzie, has provided excellent service to CCIW's reprographic needs. HDC's orderly, organized approach continues to support our cartographic unit in a most effective way. Quick access to all our records, interrogation capabilities of the nautical Geodesy data bank at Headquarters, and effective indexing and record keeping are just a few marks of success that warrant the accolades of users and managers.

Chart production achievements are listed in detail in Table 2. Briefly, 28 new editions, 10 new charts, 10 patches and 50 draft notices to mariners were produced. In addition, the unit was involved in the normal assessment and analysis required for 1211 individual submissions and 68 field sheets.

*Automated Drawing-Assisted Cartography*

In June a decision to use cartographers to test our automated drawing facilities and revise any docu-

Table 2. The 1980 Chart Production Achievements

| New Editions | New Editions | New Charts |
|---|---|---|
| 1416 | 2028C | 1552C |
| 2015 | 2028 Sh. 1 | 1552 Sh. 1 |
| 2023C | 2028 Sh. 2 | 1552 Sh. 2 |
| 2023 Sh. 1 | 2183 | 1552 Sh. 3 |
| 2023 Sh. 2 | 2204C | 1553C |
| 2023 Sh. 3 | 2204 Sh. 1 | 1553 Sh. 1 |
| 2024C | 2204 Sh. 2 | 1553 Sh. 2 |
| 2024 Sh. 1 | 2204 Sh. 3 | 1553 Sh. 3 |
| 2024 Sh. 2 | 2204 Sh. 4 | 2100 |
| 2024 Sh. 3 | 2205 | 5510 |
| 2024 Sh. 4 | 2216 | |
| 2024 Sh. 5 | 2239 | |
| 2025C | 2271 | |
| 2025 Sh. 1 | 2300 | |
| 2025 Sh. 2 | 6021 | |
| 2025 Sh. 3 | | |
| 2026 | 6242C | |
| 2026 Sh. 1 | 6242 Sh. 1 | |
| 2026 Sh. 2 | 6242 Sh. 2 | |

Note: C cover
Sh sheet

mentation on its use committed P. Warren and B. Beale to that program. The debugging and proofing of our facilities in the Region should be reflected by the production of Chart 2085, Toronto Harbour. Progress to date is better than expected, but guarded until the final check is completed and the chart is on the shelf. Upgraded documentation of the Region's system is one of the prime objectives, and ultimately, P. Warren and B. Beale will be our training expertise in this field.

*CHS/NOS Exchange*

G.B. Norris, National Ocean Survey (NOS) and P. Warren, CHS, were this year's participants in the cartographic exchange program. The exchange was beneficial to both organizations. Next year will be our final exchange before alternating on a yearly basis with A.O.L., Halifax.

*Training*

Participation in the Cartographic-1 course has been a commitment of our Cartographic Unit since the inception of the course. This year's participants were S. Bockmaster, S. Chander and B. Little.

*Staffing*

S. Bockmaster and B. Beale were successful in competing for vacant positions within the Cartographic Unit.

At present, two term positions within the Unit remain to be filled.

*Special Projects*

The number of special projects totalled seventy-six this year. The major projects were drafting and reprographics assistance for LIGHTHOUSE editions 21 and 22, the Toronto Boat Show and the annual production of Ontario's Small Craft Harbour's pamphlet. The photography of Cousteau's CALYPSO and CCIW support vessels during their visit to the wrecks of the 1812 warships HAMILTON and SCOURGE was an interesting photographic assignment.

**Tides, Currents and Water Levels**

*Field Surveys*

The major field activity for the Tides, Currents and Water Levels Section during 1980 was a winter tidal survey carried out in the M'Clintock Channel in cooperation with the PCSP hydrographic survey party. Six submersible, pressure-recording tide gauges were installed on the east and west coasts of M'Clintock Channel for a period of over one month (Figure 2). The data obtained will provide information concerning the nature of tidal propagation in the channel. Four gauges were also deployed at each of the Decca sites and at the hydrographic base camp, to record atmospheric pressure for the purpose of reducing the underwater pressure records. One gauge was also installed at the northern tip of Cornwallis Island (north of Resolute) in order to replace a deployment that was lost the previous winter.

The processing of submersible, self-recording, tide gauge data has been streamlined considerably with the completion of interactive versions of our processing programs.

The data collected by the Section in Viscount Melville Sound over the past few years have been used to construct co-tidal charts for this area. The results of this study were presented at the 19th Annual Canadian Hydrographic Conference in Halifax.

Ottboro and Aanderaa tide gauges were loaned to various agencies for deployments at Pond Inlet in Lancaster Sound, Inoucdjouac in Hudson Bay, Fort George in James Bay, and in Lake Erie.

Gauges were also supplied to hydrographic survey parties in Lake Nipissing, Lake Erie, the St. Lawrence River, and Quebec Region, and to the aerial hydrography survey on the Bruce Peninsula. A number of survey parties obtained water level data required for the reduction of soundings directly from TATS units installed in permanent gauging stations.

*Permanent Gauging Stations*

A new permanent gauging station was constructed on Lake Ontario at the entrance to Hamilton Harbour to replace the previous station located at the Burlington filtration plant. The new station will be instrumented with a TATS unit and will also serve as a site for testing of new instrumentation. Major reconstruction was carried out at the permanent gauging sites at Port-St-Francis and Quebec City (Lauzon) on the St. Lawrence River.

The TATS units installed in Central Region have produced a number of problems this year. As a

result, the maintenance of the TATS units by both the Tides, Currents and Water Levels Section and the Tidal Instrument Development Section has increased over last year. Expansion of the TATS system will await the resolution of these problems by the manufacturer.

The maintenance of a total of 28 remote telemetry and teleannouncer units at permanent sites was again contracted to Marinav Corporation in 1980.

The monthly editions of the Great Lakes Water Level Bulletin were mailed free of charge to approximately 2000 subscribers. An additional 2500 copies were distributed at the Toronto Boat Show in January.

*Other Activities*

The Section represents the Canadian Hydrographic Service on the Vertical Control-Water Levels Subcommittee of the Coordinating Committee for Great Lakes Basic Hydraulic and Hydrologic Data. The major topics addressed this year were the re-evaluation of International Great Lakes Datum and the updating of a history of the gauging stations on the Lower Great Lakes.

The Regional Tidal Officer participated in a CHS Task Force on tide gauging and current measurement in the Canadian Arctic. The Task Force developed recommendations for future surveys to meet anticipated navigational requirements.

Mr. J. Rae from the Instrumentation Group at the Institute of Oceanographic Sciences, Bidston Observatory, Birkenhead, U.K., visited the Section during the summer to discuss developments in automated water level recording.

**Tidal Instrument Development Section**

The Tidal Instrument Development Group provides specialized instrumentation development to support the measurement requirements of the regional tidal officers of the Canadian Hydrographic Service. This support includes participating in the analysis and definition of measurement requirements, managing contracted or in-house development activities, resolving operational and maintenance problems, and recommending technical developments which may benefit the Service.

*Tidal Acquisition Telemetry System*

Experience with the commercial TATS units in 1980 has not been as encouraging as that of 1979. Problems with the power supply design, grounding, and other non-critical functions have increased maintenance efforts. Discussion with the manufacturer regarding the problems and other improvements are continuing.

Special versions of TATS have been configured to support Arctic hydrographic surveys, to provide radio-link communications with field officers, and to interface with the International Tsunami Warning System via a satellite Data Collection Platform. The Arctic and RF TATS units have been successfully field tested in M'Clintock Channel and in the St. Lawrence River, respectively. The development of the Tsunami TATS for the Pacific Region has been delayed.

*Ocean Tidal Data System*

An unsolicited proposal by D.G. Instruments for an Ocean Tidal Data System has been supported by CHS and will lead to the development of intelligent tide gauges, with the data recorded in a non-volatile solid state memory. The design incorporates features and functions suggested by the regional tidal officers and technical staff.

*Hydrographic Tide Gauge*

Development of the hydrographic survey tide gauge has been slowed as a consequence of modifying the system to include data logging which will support tidal analysis following the survey. The compatibility of the design and hardware work to date with the D.G. Instruments development is being explored, with a view to developing a low power Radio-Arctic TATS system as an alternative to the previous Arctic TATS.

**Hydrographic Arctic Research Project**

The Hydrographic Arctic Research Project (HARP) continues to be the primary source of funds for hydrographic research and development in the field of Arctic marine transportation. The funding for HARP is provided by the Interdepartmental Panel on Energy, Research and Development of the Strategic Studies Branch, Transport Canada. Although Central Region coordinates the HARP program, each Region participates actively in the wide range of projects sponsored by HARP.

Central Region's HARP projects can be grouped into three categories: 1) through-the-ice sounding techniques, 2) digital data storage, and 3) tidal propagation. Efforts to improve the present technique of sounding through the ice have concentrated on the actuators for the 'spike' transducers and a major investigation by Huntec Inc. into the use of non-linear acoustic techniques. The research into non-linear acoustics is progressing well and the testing of prototypes is expected by mid-1981. The method looks promising if the prototype can withstand the rigors of the Arctic environment. Research into the storage of digital data has focused on the design of a solid state, magnetic bubble memory system which could withstand the harsh conditions of Arctic surveying. To increase the knowledge of the propagation of the tide in the Arctic Islands, the Tides, Currents and Water Levels Section conducted a tidal survey of M'Clintock Channel.

**Plans for 1981**

Two northern hydrographic surveys are scheduled for 1981. The PCSP survey party will return to last year's base camp on Prince of Wales Island to collect spot soundings in southern M'Clintock

Channel and Larsen Sound. The Earth Physics Branch, DEMR, will also collect gravity readings in the same area. In Hudson Bay, the Region plans to survey the approaches to Chesterfield Inlet.

In the Great Lakes Region, the ongoing surveys of Lake Nipissing, North Channel of Lake Huron and the St. Lawrence River will continue from last year's work. Similarly, the Revisory survey will concentrate in areas that are scheduled for chart production in 1981. In addition, an interlining of the limnogeology soundings in Southern Lake Huron will be undertaken.

The Hydrographic Development Section plans to interface an accurate pointer with the GOMADS system during the upcoming year. In addition, cassette recorders and BUBBLE BOX units will be field tested with NAVBOX during the summer season. The Section will also conduct field tests of MARRS in the Arctic and assess its suitability for detailed surveying in frozen seas.

A major Arctic Tidal survey has been proposed for Norwegian Bay and Barrow Strait during 1981. In Norwegian Bay, the Tides, Currents and Water Levels Section will work in conjunction with Panarctic Oils Ltd. to install four submersible tide gauges. In Barrow Strait, a total of eleven deployments are planned. Two of these deployments will be left for approximately one year and recovered under the ice in 1982. The Section also intends to test an RF Arctic TATS at Resolute Bay.

The Tidal Instrument Development Group is committed to resolving the reliability problems of the TATS units. A revision of the sampling procedure software that will make TATS data more suitable for tidal analysis is also planned. D.G. Instruments will produce six tide gauges for evaluation by the Regions. The hydrographic tide gauge will be developed further to provide expanded data logging and increased accuracy.

The Region will host the 20th Annual Canadian Hydrographic Conference this Spring. Preparations are well under way to ensure the conference provides a good exchange of information and comradeship.

The objectives of the Chart Production Unit are to produce 6 new charts of the Ottawa River, Toronto Harbour and Lake of the Woods, and 20 new editions. In addition, the Cartographic Unit will make substantial contributions to the Toronto Boat Show and the 20th Annual Canadian Hydrographic Conference.

## RESEARCH & DEVELOPMENT DIVISION

### Introduction

The Research and Development Division is the oceanographic, shore properties and electronic support component of Central Region. Geographically its research programs extend from the Great Lakes system to the sub- and high-Arctic environments of Hudson/James Bays and the Northwest Passage.

In the north, the Division's oceanographic programs are responding to information requirements for frontier oil and gas exploration and development, hydro-electric development, marine transportation and the need for environmental assessments. On the Great Lakes, shore erosion studies are providing a better understanding of coastal geomorphological processes for the development of improved shore management policies.

### Physical Oceanography

Dr. E.B. Bennett, who has worked as Petrocan's senior oceanographer responsible for the design and coordination of marine programs in the Arctic, joined the Division late this year as a research scientist in Arctic oceanography.

*Physical Oceanographic Climatology of the Central Arctic (E.B. Bennett)*

The Division's Arctic oceanographic studies in the past have been aimed at describing circulation characteristics of interconnecting channels of the archipelago. Data from the 1979 survey of water structure and currents in the Sverdrup Basin and Viscount Melville Sound were published.

With the increased likelihood of tanker traffic in the Northwest Passage, however, emphasis is being shifted to developing a long-term measurement capability at a specific location (Barrow Strait). Data on under-ice current structure and water transport will be collected in order to assess inter-seasonal and inter-annual variability, with special reference as to their effects on, and how they will be affected by, Arctic-marine transportation and resource development.

This continuing study, which is comprised of analyses of existing data, field measurements and theoretical development, is being coordinated with the Biological Oceanographic Program of the Division, and the western and eastern Arctic studies of the Institute of Ocean Sciences and Bedford Institute of Oceanography.

*Physical Oceanographic Studies of Hudson Bay (S.J. Prinsenberg)*

Baseline conditions of salinity, temperature and currents are being determined based on observations taken throughout Hudson Bay during the summer of 1975 and 1976. Because of large variations found in time and space in current and CTD data, meaningful average values are hard to define. This data was used in the papers on man-made changes in the freshwater input rates of Hudson Bay and James Bay and on the spatial and temporal variability of oceanographic parameters in Hudson Bay, as well as an assessment of the environmental sensitivity of areas designated by EMR for oil and gas exploration activity.

Work continued on the development of analytical techniques to distinguish between the wind-driven components of the current and the mean circulation. Using a one-dimensional surface layer model which included heat, mass and momentum surface fluxes, analysis of the wind effect on the vertical structure of the water column was started. Seasonal variation in the mixed layer depth was compared to available data, and effects on it due to hydroelectric developments were obtained for Hudson Bay and James Bay.

*Arctic Coastal Inlets (W.P. Budgell)*

Coastal inlets and fjords are ecologically sensitive areas which may be profoundly influenced by resource extraction (oil, gas, minerals, etc.).

At the present time, with the exception of a few isolated studies, the physics, chemistry and biology of Arctic inlets and fjords are virtually unknown.

Plans for the study of the physical oceanography of Arctic coastal inlets to relate the effects of physical processes upon nutrient and biomass distributions are underway. The study will provide baseline information on the circulation, tidal dynamics and heat budget of Arctic inlets and will be applied to environmental impact assessments.

A theory was developed to describe the influence of stochastic processes upon the water level and integrated transport in tidal estuaries. The combined stochastic-deterministic equations describing tidal hydrodynamics in branched estuaries were solved using numerical techniques. The results were tested against field data from Chesterfield Inlet in Hudson Bay and from the Great Bay estuary in New Hampshire.

The approach has three main applications.

1. The real-time forecasting of water levels and flow rates can be carried out using the most recent observations.
2. The spatial distribution of water levels and flow rates can be more accurately determined than by using existing techniques. Hydrographic soundings can be reduced to datum more accurately.
3. Friction factors and other unknown numerical model parameters can be estimated from field data.

*Freshwater Plumes (N.G. Freeman)*

This project is one component of a number of studies directed at understanding the effects on the marine environment of alterations in freshwater discharge brought about by hydroelectric construction on the La Grande River, James Bay.

It is anticipated that twelve times as much water as

is discharged naturally will occur during the maximum winter power demand, resulting in a much deeper and broader freshwater plume under the ice.

Thus it is the specific objective of this project to examine the role of river discharge, ice cover, and tidal energy in the convection and dispersion of this additional freshwater in the Bay, through field measurements and numerical modelling of the freshwater plume dynamics (Fig. 9).

A further objective, being carried out principally by the University of Guelph, Zoology Department, is to investigate the role of the freshwater plume in nutrient supply and biological productivity.

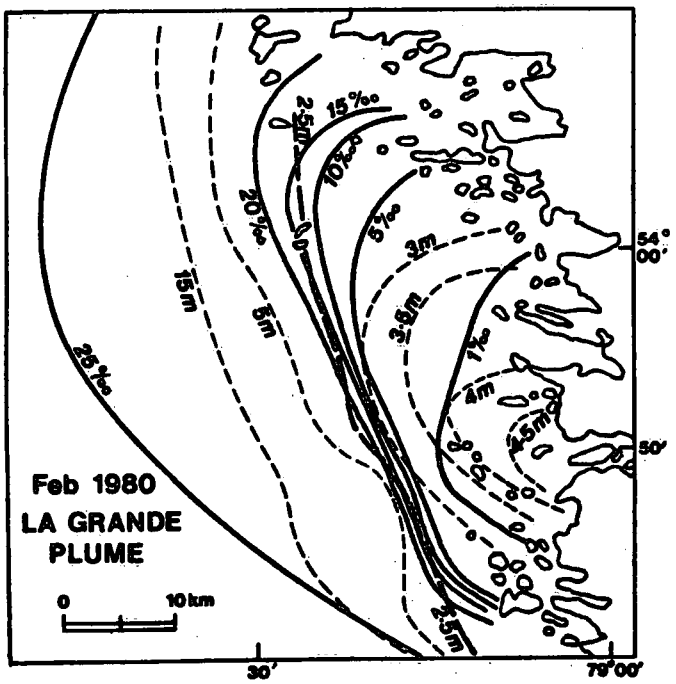



Figure 9. Salinity and pycnocline depth contours of La Grande River plume.

An oceanographic field program was carried out in February and March 1980 to measure changes in the distribution of physical and biological parameters in the La Grande River plume, under an increased post-project discharge of 3-4 times the natural flow. The plume approximately doubled in surface area and thickness over pre-project measurements carried out in 1975 and 1976. Vertical profiles of salinity, temperature and current at some twenty locations along and across the plume axis provided strong evidence of tidal control of mixing in the far field and river control in the near field. A vertically-integrated, one-dimensional, steadystate model reproduced the interface slope balance well, but required further refinement of the entrainment model to reproduce along-stream mixing. Work is also proceeding on a two-layer, tidally-averaged model, to better represent mixing in the far field.

Preliminary results from the biological survey indicate that seston levels (POC & BIOC) reach maximum values in the near field region of the plume (.1 to 1°/oo), indicating a riverine source. The distribution of silica, whose source is not riverine, indicates that in the far field bottom topography and tidal energy may be important by causing local physical suspension. Other nutrient phytoplankton populations and chlorophyll act relatively conservatively. Although the sea ice contains substantial levels of nutrients and particulates, it appears that the sea ice is not a significant source of either in mid-winter months.

*Estuarine Circulation (L.R. Muir)*

A PhD thesis was written and successfully defended at the Department of Oceanography, University of Southampton. In this thesis the tidally-averaged depth-density relationship and the current meter records collected from previous St. Lawrence surveys were examined, and it was shown that both barotropic and baroclinic tides are important in the circulation of the estuary. In addition, the horizontal density gradients, while not affecting the propagation of the waves, do contaminate the observations considerably. In general, it is not possible to determine the wave field which gives rise to a particular set of measurements at a single location and, hence, it is necessary to make measurements synoptically. The interaction of all of the physical processes controlling the circulation of the estuary is discussed at some length.

Microzones (patches of zooplankton excretion products) have been thought to be important in providing for the nutrient requirements of marine phytoplankton in oligotrophic area. However, these microzones are controlled by molecular diffusion and it has been shown that, even under the most favourable circumstances, these microzones will diffuse away too rapidly to be of any use to the phytoplankton. This work was done in conjunction with Dr. P.J.L. Williams of Southampton University.

*Biological Oceanography (N.H.F. Watson)*

This year marked the first complete year for a biological oceanographic program being carried out under a secondment basis with Dr. N. Watson from the Great Lakes Biolimnological Laboratory.

Objectives of the program are to use nutrient chemistry and species composition data in conjunction with physical measurements to identify water mass movements in the Arctic Archipelago, to identify species assemblages primarily in Hudson Bay and Chesterfield Inlet, and to develop methodologies for evaluating the role of physical processes and nutrient concentration in producing observed biomass and species distributions in Chesterfield Inlet. These three types of activities are necessary for meeting present and future requirements of providing baseline distribution and abundance information in the high Arctic, as well as identifying sensitive areas, understanding the factors supporting production, and the role of key species in the Arctic marine ecosystem.

Supervision of subvention and contracted work in Chesterfield Inlet and the La Grande River estuary

resulted in the publication of the nutrient chemistry and biomass parameter data collected to date. Two MS theses on the phytoplankton and zooplankton of Chesterfield Inlet were also supervised, with their completion expected in February of 1981.

A biological survey will be undertaken in conjunction with the Arctic Physical Oceanographic Program in Barrow Strait in the spring of 1981. Observations will include spatial and temporal distributions of nutrients and planktonic organisms for key indicator species. This data, in addition to its scientific value, would be available for contingency planning, and for operational use in the event of a marine disaster.

**Shore Properties Studies**

Comprehensive shoreline inventorying and erosion monitoring programs were initiated in 1973. Because of the temporal and spatial continuity of this data base, it provides fundamental information toward the development of sound shore management practice and planning throughout the Great Lakes.

*Erosion Monitoring (W.S. Haras and G.L. Boyd)*

Under the aegis of a Canada/Ontario Agreement, stage-related onshore and offshore erosion profile data is collected at 162 sites, to develop a better understanding of erosion processes in the Great Lakes system. Annual field and photographic surveys culminated this year under the existing five-year Agreement.

An interim report was prepared documenting short-term erosion rates needed in establishing building setback calculations and shoreland planning. The report also provides some insight to the complex interaction of geomorphological processes for the Great Lakes glacial physiographic regions generally, and as related to individual sites specifically.

The optimum time to calculate representative short-term bluff erosion rates has been found to be when the bluff returns to its original profile. These representative rates define the high water level sediment transport budget for the shore system.

No correlation between beach changes and water levels has been identified, probably because the water levels have not yet subsided sufficiently. However, by grouping the nearshore profiles using morphological and compositional criteria and subsequently correlating them to onshore observations, meaningful distinctions have been made concerning the causes, rates and modes of erosion not otherwise possible using onshore observations only.

This program is scheduled to be renewed for another five-year term pending extension of the existing Agreement. Based on the findings within the Interim Report, however, emphasis of the offshore measurements will be shifted to monitoring the littoral sand prism in the immediate nearshore zone.

*Site Specific Projects (W.S. Haras and G.L. Boyd)*

There are a number of ongoing special projects, most of which are related to assessing the effects of artificial structures on shore processes in quantitative terms. Projects include headland developments at Fifty Mile Point and along the Toronto waterfront on Lake Ontario; groyne protection at Kew Beach on Lake Ontario and Long Point and Point Pelee on Lake Erie; harbour structures at Goderich and Oshawa; and sand nourishment projects at Port Stanley and Point Pelee. A report was prepared describing the results and recommendations to date on the Point Pelee Erosion Programme. The twenty-four profile locations spaced strategically around the perimeter of Point Pelee National Park were surveyed in the spring, summer and the fall, recording seasonal changes. Also, the breach at East Beach was surveyed on a much tighter grid to determine the stability of the artificial nourishment that is being used to close the gap.

Oblique slide photography and videotapes were used to establish the extent and predominant types of shore protection structures on the erodible shoreline of the Great Lakes from Sauble on Lake Huron to Presqu'ile on Lake Ontario.

*Coastal Zone Management (N.G. Freeman, W.S. Haras and G.L. Boyd)*

Direction of governmental efforts toward coastal zone management is being coordinated jointly by a Task Force composed of members from the Ontario Ministry of Natural Resources, the federal Department of Fisheries and Oceans and the federal Department of the Environment. They direct the Great Lakes Shore Damage Survey follow-up programmes, including a Public Awareness programme, the Erosion Monitoring Programme, and a Shore Management Study, with the aim of decreasing shore damage and improving coastal zone management of the Great Lakes Canadian shoreline. International dialogue is attained through membership on the IJC Lake Erie Regulation Study, Coastal Zone Subcommittee, the Great Lakes Basin Commission's Standing Committee on Coastal Zone Management, and the Coastal Hazards Subcommittee. Local requests are received from the public, government agencies, universities and courts for information concerning the shore zone of the Great Lakes.

Through the CTF, an ad placed in major newspapers serving the Great Lakes area resulted in over 1000 requests for brochures, information on and about the Great Lakes, together with problems associated with living on their shore; a postcard display was also prepared, slide shows were assembled and presentations made. Review and editing of the "Basic Guidelines for Great Lakes Shore Management" was completed and a worked example for these guidelines was prepared.

Through the International Committees, the Shore Properties Studies Section acted as Canadian Secretary to the Coastal Zone Subcommittee of the International Lake Erie Regulation Study and supplied data, analytical results, photographs, assisted in methodology formulation and review of the final report to the Working Committee of the IJC.

*James Bay Estuarine Erosion Monitoring (W.S. Haras and J.R. Shaw)*

Four estuaries on James Bay are being monitored annually to record baseline erosion information. Field surveys are undertaken at the Albany and Attawapiskat Rivers on the west side of the Bay, and at the Eastmain and La Grande Rivers on the east side of the Bay. Information collected includes river bank profiles, stratigraphic samples and photographic documentation (Fig. 10).

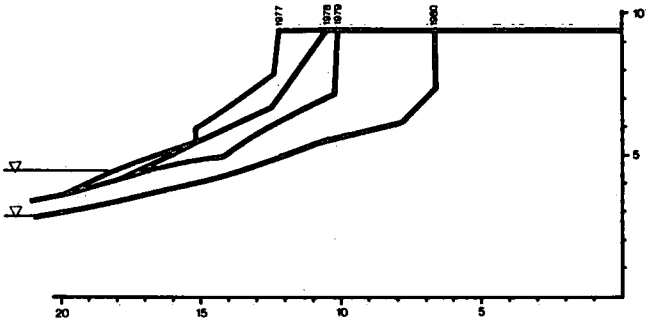



Figure 10. ATTAWAPISKAT RIVER
— Annual changes in bluff profile at monitoring station ATT-30
— Scales are in metres

The Albany and Attawapiskat surveys are in conjunction with a sedimentological study by the University of Guelph as part of a multi-disciplinary Hudson Bay Lowlands Baseline Studies Program of the Department of Environment.

At the Eastmain and La Grande Rivers the impact of altering the rivers' discharge due to hydroelectric development will be quantified by comparing post-project to pre-project erosion conditions.

An intercomparison of pre-project erosion characteristics of the four estuaries, each having unique physical properties, will provide a better understanding of the physical processes controlling erosion in a sub-Arctic estuarine environment.

**Ice Studies**

Two projects related to ice studies in the central Arctic are being initiated by the R&D Division.

*Ice Radar (E.O. Lewis)*

The main effort of the Sea Ice Radar project is concentrated on understanding the electrical characteristics of ice and the physics of the radar signal for the design of remotely-mounted radar systems to delineate ice conditions for navigation, research and information required in the event of a marine accident. A contract was issued to McMaster University to evaluate the existing knowledge of the electrical properties of sea ice and its interaction with radar signals. Preparations are underway for field investigations to be carried out on Borden Peninsula during the Arctic oceanographic survey in the spring of 1981.

*Ice Physics (E.O. Lewis)*

Work also commenced on the development of a portable ice physics laboratory for Arctic sea ice studies and a long-term ice physics measurement program in the Northwest Passage. The laboratory is designed to contain all equipment necessary to undertake measurements of the physical and electric properties of sea ice, and will include the development of a standard procedures manual for the use of the equipment. Evaluation tests are planned during the Arctic oceanographic program in the spring of 1981 in Eclipse Sound.

**Environmental Assessment/Ocean Information**
*(J.R. Shaw)*

The main role of this Section is to coordinate Central Region, Ocean Science and Surveys' reviews of environmental assessment material submitted by the Ontario Region Screening and Coordinating Committee of EARP, regulatory agencies (DINA and EMR), other government departments (DOE) and DFO Headquarters. The Section provides a Regional communication focus for ocean information and other scientific programs.

The emphasis for Regional reviews of environmental assessments this year reflects the surge of exploratory activity and production planning for the development of offshore natural gas and oil resources in the north. Twelve of the nineteen major reviews undertaken were related to hydrocarbon development, including the Arctic Pilot Project (emphasis being on the assessment of the effects of marine transportation through the Northwest Passage), drilling applications submitted to DINA by Panarctic, and an assessment of the Hudson Bay marine environment and its sensitivity to possible future exploratory drilling activity. Other reviews related to oil and gas environmental assessment in general were Canada's new Oil and Gas Production Regulation, a Canada/US Draft Response Plan for Boundary Waters, an Environmental Policy for the 1980s, operating Guidelines for DFO's participation in EARP, new legislative proposals for EARP, and the Lancaster Sound Green Paper. On a broader national perspective some insight was gained on

east coast exploration activities through the review of company contingency plans while on secondment to DFO Headquarters.

Under the Regional Screening and Coordinating Committee of EARP and the marina Policy Assistance Program of DFO, seven projects having potential effect on the Great Lakes environment were assessed. Most of these were related to shore management strategies to prevent damages from flooding and erosion.

**Program Support**

*Ocean Operations (D.J. Brooks)*

The major field project of 1980 was the winter oceanographic survey in James Bay, and consisted of the collection of physical and biological data off the La Grande Estuary. Two helicopters were used to accommodate the installation of eleven current meter mooring stations, twenty-one 25-hour current meter and CTD profile stations, and three hundred and sixty-eight single CTD profile stations (Fig. 11). Thirty-six biological water samples and thirteen ice samples were also collected, along with eight zooplankton and ten ice fauna stations.

Figure 11. Deployment of current meter at James Bay.

The 1981 Arctic Oceanographic project commences in March with new equipment and advanced techniques for installation of Arctic moorings. Some equipment being tested are in-house designed embedment anchors, biological water sample bottles, and an underwater vehicle for joining ice holes.

Long-term objectives include the upgrading of Arctic oceanography techniques and methods of reducing corrosion of instruments during long-term installation.

*Ocean Instrumentation (S.D. Baird)*

Ocean Instrumentation saw its busiest year on record. Support to OSS programs and projects of other agencies increased dramatically in the year, and, with the assistance of seconded personnel, significant technological advances were made in development.

Examples of major support services included the provision of instrumentation and expertise to oceanographic surveys on the coast of James Bay, Pond Inlet (Baffin Island) and Lancaster Sound, OSS projects of Quebec Region, research by McMaster University, and two projects by the National Water Research Institute, Department of Environment.

Developments included a gyro-referenced current profiling system (G-UMPS), funded in part by Transport Canada, for the collection of oceanographic parameters in areas of low horizontal magnetic intensities; an Aanderaa Data Tellemetry System for use with up to three current meter moorings simultaneously over a range of 25 miles.

*Data Processing and Programming (C. Doekes)*

A data processing, systems and program development service is provided to the scientific and engineering staff of the R&D Division. Oceanographic data (time series and profile) are processed using existing software on the CYBER 171 computer at CCIW. These systems require modification and enhancement on a regular basis. In addition, new systems and programs are developed in order to meet the changing instrumentation and scientific requirements.

During the year, the Computing and Data Processing Section provided programming and field processing support for the La Grande 1980 Survey which made extensive use of the HP-9825A desk top calculator. Considerable programming support was provided to Shore Properties Studies, both as aid in converting this system from card to disk/tape and in developing new applications. Computer programs were developed to interpret and plot data collected during the Arctic Solar Project. Limited program conversion support was provided to GLBL.

A system was developed to interpret and process data from Marsh-McBirney current meters. It was designed, where possible, to interface with existing current meter systems and programs.

The Norpak MVP Graphics System was a continuing source of frustration. Hardware problems of various kinds continued to appear, and often required returning the equipment to the manufacturer for solution. Although not all problems have been resolved to date, significant progress has been made, and those remaining are in the process of being resolved.

Work with the system consisted primarily of extensive testing and the development of the required Assembly Language routines, to enable the Interdata minicomputer to communicate with the graphics system and vice versa.

A major emphasis in the next five years is to redesign most of the existing systems and programs and

to implement them on the in-house mini-computer, an Interdata Model 70. In all cases, the Norpak MVP graphics system will be used as extensively as possible, in order to facilitate data manipulation and editing and the production of data reports.

*Survey Electronics (W.J. Montgomery and B. Waldock)*

A prototype SUDS unit (self-contained underwater digital sonar) was constructed during the summer of 1980 by the Development Section of Survey Electronics to assist studies of sediment drift in the Great Lakes by NWRI. The unit was deployed six times during the months of September-December 1980 and successfully recorded sediment changes during several storms.

A cassette tape Aanderaa Data Logger was also developed for use with the UMPS and G-UMPS auto profiling systems. This logger will be used to replace the small paper tape printer used in previous surveys. The logger decodes Aanderaa current meter data and formats it onto a digital cassette tape. The data may be dumped, using the same unit, into a computer or line printer through a standard RS232C communications line.

Other developments included a second edition of an accurate shallow water digital sounder to measure small changes in depth, caused by sand migration below a fixed transducer located near the shore of a lake, and a voltage protection circuit for launches to protect electronic equipment from voltage anomalies from the boats' generating system.

The previously-developed portable solar panel and timer are now being used as a standard hydrographic tool. The timer has been redesigned to fit inside the transponders, thus making it more convenient.

The electronics shop also supplied expertise in the operation of Loran-C and antenna design to a joint project with other regions of OSS, MOT, and Dome Petroleum. This test, conducted in the Beaufort Sea, evaluated Loran-C as a tool for positioning and avoiding pingos.

## SHIP DIVISION

### Operations

*CSS LIMNOS*

During the 1980 navigation season, CSS LIMNOS steamed a total of 15,922.3 nautical miles while participating in 21 scientific cruises, all but one in support of surveillance and NWRI programs. These cruises were carried out over an area ranging from Lake Ontario to Lake Superior, including Georgian Bay and the North Channel.

LIMNOS was scheduled to sail on the first of these cruises on March 17th. However, due to maintenance difficulties with the Burlington Canal Bridge, the sailing date was postponed until March 24th.

During the season, LIMNOS was operational for a total of 269 days; however, only two days were lost due to minor engine problems while the vessel was on survey duties in Georgian Bay during the month of September.

On November 9th the vessel returned to Burlington with all scheduled cruises completed, and remained on standby until November 28th when she was withdrawn from service for the winter months. During this standby period, LIMNOS spent one day on Lake Ontario participating in a mooring retrieval.

*CSS BAYFIELD*

After an extensive winter refit, BAYFIELD was prepared for GLBL surveillance survey. The vessel departed on May 26th and sampling was carried out on Lakes Ontario, Erie, Huron, and Superior, including Georgian Bay and the North Channel. When this survey was completed, BAYFIELD returned to Burlington and was made ready for an offshore Hydrographic survey in central and eastern Lake Erie.

Throughout the summer months, BAYFIELD participated in the Lake Erie survey until September 21st, and then proceeded to Lake Huron to carry out Loran-C calibration trials. On the return trip, the remainder of the Lake Erie survey was completed in the Long Point area and the vessel returned to Burlington.

At Burlington, BAYFIELD was once again outfitted for an Upper Lakes surveillance cruise for GLBL. This cruise was completed on October 25th, when, once again, the vessel returned to Burlington to remain on standby until November 1st, when she was decommissioned.

During the survey season BAYFIELD steamed a total of 13,753 nautical miles and was operational 164 days. One day was lost due to mechanical repairs and seven days were lost due to inclement weather conditions.

*CSS ADVENT*

During the winter months, ADVENT received a major engine room refit. The two main engines and two generators were removed from the ship, rebuilt and reinstalled.

On May 12th, ADVENT became operational, and, after trials, spent two days supporting a remote sensing study on Lake Ontario. On June 2nd, the vessel proceeded to Lake Erie, where it was stationed for the summer months.

Based at Erieau, ADVENT participated in a National Water Research Institute temperature study, and was also multi-tasked for Search and Rescue until October 14th, when the vessel returned to Burlington. ADVENT remained on standby and was used on a short-term basis in Western Lake Ontario until December 12th, when she was moored in her winter berth and decommissioned for the season.

### Great Lakes Biolimnology Laboratory

*MV LAC ERIE*

Once again, a vessel charter was negotiated and LAC ERIE was taken on charter hire. The vessel arrived at Burlington on July 28th, and was equipped for a benthos survey of the North Channel and Northern Georgian Bay.

In transit to the survey site, LAC ERIE towed the barge GULL and a VAPS buoy to Lake Erie, then proceeded to Georgian Bay, arriving at Manitowaning on August 7th to commence the survey.

On August 26th, the survey was completed and the vessel proceeded to Erieau to assist in scientific studies being carried out in Central Lake Erie. On September 5th LAC ERIE returned to Burlington and, after equipment removal, the vessel was taken off charter and returned to the owners.

*Quinte Survey*

At Burlington, AQUA was once again made ready for the Quinte Survey, and, after trials, departed for the survey area on April 28th. Based at Prinyer Cove, AQUA was multi-tasked for the GLBL survey and Search and Rescue in that area.

In order to provide full coverage for both survey and SAR duties, SURF was taken to the site and used as a standby launch. In addition to these launches, one Boston Whaler was used on the Quinte Survey throughout the season.

On October 14th, the survey was terminated and all launches and equipment returned to Burlington.

*Acid Rain Survey*

Acid rain studies were carried out in the Turkey Lakes, Algoma and Sudbury areas. Ship Division supplied this program with ten small craft, some with electric outboard motors.

One helicopter was supplied for this program during a two-week period in the spring, working in the Algoma, Sudbury and Georgian Bay areas. In the fall, four weeks of helicopter time was supplied working in North Central Ontario from Atikokan to Parry Sound.

**Hydrographic Division**

*Lake Nipissing Survey*

The Lake Nipissing Survey commenced early in May, when all survey equipment was moved from North Bay to Sturgeon Falls, which was used for a survey base. Launches HELIX, HORNET, LAB #1, two Boston Whalers and two small aluminum boats supported this program.

Operations continued from this site throughout the season until October 17th, when the survey was terminated and all launches, equipment and personnel returned to Burlington.

*North Channel Survey*

This was the first season for the North Channel Survey, which commenced on May 1st when launches NAUTILUS and NIMBUS departed Burlington and sailed to Thessalon. LAB #3, one Boston Whaler and one small aluminum boat were road transported to Thessalon, which was used for the survey base.

NAUTILUS was multi-tasked for Search and Rescue on a 24-hour, 7 days a week basis, while NUMBUS and the remainder of the small craft worked regular survey hours.

By October 15th, all small craft were taken from the water and prepared for the return trip to Burlington. NAUTILUS and NIMBUS departed Thessalon on October 16th and sailed to Burlington, arriving here on October 24th.

*Lake Erie Survey*

CSS BAYFIELD supported this survey, as well as CSL BRONTE, HYDRO I and HYDRO II. On May 1st, launches and survey equipment were road transported to Port Stanley. The survey operated from this site until August 11th, when the base was moved to Port Burwell and operated from there until the end of the season. By October 24th, all launches, equipment and personnel were returned to Burlington.

*Nanticoke Survey*

This survey consisted of a harbour and main channel survey at Nanticoke and was supported by one Botved launch, HYDRA. Ship's crew and Hydrographic personnel travelled daily to and from Burlington to the survey site from April 16th to July 11th, when the survey was temporarily terminated.

On September 22nd, the survey once again resumed, using HELIX, and was completed by November 21st, at which time the launch and equipment were returned to Burlington.

*St. Lawrence River Survey*

The St. Lawrence River Survey resumed in May and was supported by three Botved launches, HASTY, HUSTLE and HUNT, as well as two Boston Whalers. All launches and equipment were road transported to Brockville, and by May 13th the sounding program had commenced.

All launches and equipment were returned to Burlington by October 17th.

**Research and Development Division**

Shore Properties Studies were supported once again with an 18-foot Crestliner boat. This survey ranged from Eastern Lake Ontario to Lake Huron, including Georgian Bay.

The James Bay Winter Oceanographic Survey was provided with two quartermasters who assisted with the preparation and transportation of the survey equipment to Fort George. Ship Division arranged for two helicopters which arrived at the survey site on January 27th, and worked extensively in the James Bay area throughout the survey.

After the survey camp was set up, one quartermaster returned to Burlington and the other assisted with the survey until it was terminated. By April 1st, all equipment and personnel had returned to Burlington.

**"The CALYPSO Caper"**

A highlight of the year occurred when the Cousteau research vessel CALYPSO docked at CCIW and worked in this area on two different occasions. The purpose of these visits was to obtain film footage of the sunken 1812 warships, HAMILTON and SCOURGE.

CSL SHARK played a major role in this operation by positioning the CALYPSO over the wrecks and providing considerable assistance in the enterprise. A helicopter was made available to support the program by transporting personnel and equipment to the site.

During the second visit to the HAMILTON/SCOURGE site, LIMNOS also provided invaluable assistance by laying an anchoring arrangement for CALYPSO.

**Search and Rescue**

Search and Rescue in Central Region resumed after approval was received from the ADM, with instructions to implement the 1980/81 SAR plan.

Immediate action was taken to multi-task ADVENT and two launches, AQUA and NAUTILUS. Additional Ship's crew personnel were taken on strength, and accommodation, land rental and docking space arranged for.

ADVENT was stationed at Erieau in SAR Area 106, and was involved in six SAR incidents. NAUTILUS was multi-tasked at Thessalon, where a Hydrographic survey was carried out in SAR Area 102. The launch participated in six SAR incidents, of which one involved a 17-foot boat that capsized. Four of the people on board this boat were drowned, but, fortunately, NAUTILUS did save one person who had been in the water for 17 hours before being picked up.

In Area 109, AQUA was multi-tasked and based at Prinyer Cove. This site was chosen due to the high boating population in that area. During the summer,

AQUA was involved in 17 SAR incidents.

As the surveys were terminated, these vessels were taken off SAR and remained on operational standby until decommissioned for the winter months.

**Boatshop**

The boatshop was its usual busy self during the early part of the year, particularly so with the early season start for NAUTILUS and NIMBUS, both of which were in service one day or another in March, NIMBUS being outfitted and shipped to Dartmouth for evaluation purposes at Bedford Institute of Oceanography, and NAUTILUS to film the LIMNOS' first voyage of the season for the Public Awareness Program.

Both NIMBUS and NAUTILUS were subjected to exhaustive testing prior to their departure for the North Channel Survey.

Permanent repairs were carried out to the damaged bottom plating of the SHARK prior to her being removed from service to be handed over to Crown Assets for disposal.

One experimental craft was prepared for service by boatshop personnel (a glass-bottomed boat for Fisheries), the idea being to observe underwater wildlife from within. While the construction itself was a success, the actual viewing apparently was not.

Both HYDRO III and IV were completely refurbished, and, complete with new engines and outdrives, transported to the Quebec Region.

During the early and mid part of the summer, all the non-active vessels on base were dewinterized, made operable, tested and returned to service. During this operation, it was found necessary to remove the engine from CSL BRUCE, repair and replace same.

CSL BRANT and BITTERN, inactive for five years, surprisingly started at first turn of the key, which says a lot for the Volvo Penta diesels installed.

Also, at this time, work was completed on the inboard engine test setup, which allows rebuilt engines to be tested at idle and under load, electronically tuned, and hot torqued, prior to shipment to the field.

Apart from the electronic equipment, the unit was constructed from scrap obtained from the various scrap bins around the Centre, and is proving to be worth its weight in gold.

The first of the new Volvo 4-cylinder, OHC engines was installed in the revisory launch during a summer refit period, and by all accounts from the field proved to be a great success, having seemingly more power than the old engines for less fuel burned.

Over the past three years of operating, a close check has been kept of the fuel consumption on NAUTILUS and NIMBUS, indications being that only a little over 50% of the rated engine horsepower is being utilized, leading to the opinion that a lighter, less powered engine could be used in future vessels of this design.

*CSS ADVENT*

Rebuilding of main engines and generators, together with switchboard modifications giving an auxiliary power potential of 220V, 3 phase and single phase greatly improved the versatility of the vessel. The installation of smaller injectors in both main and auxiliary diesel, while reducing her speed slightly, resulted in fuel savings and increased efficiency far outweighing any speed loss.


New SHARK

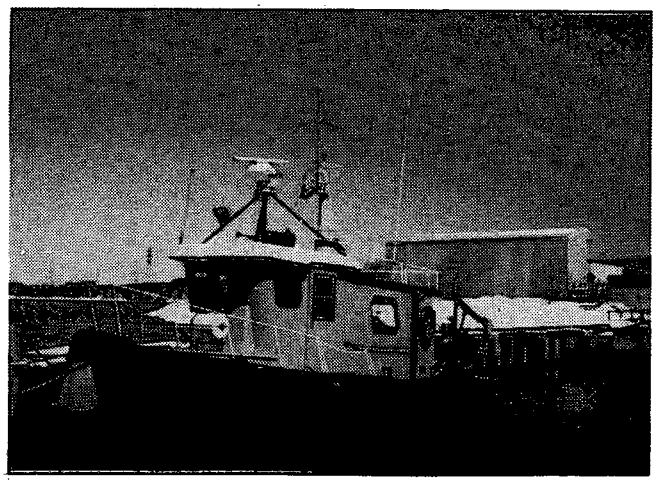
**New Acquisitions**

The dive tender SHARK was replaced this year with a new vessel, STAN DUPONT II, immediately renamed SHARK.

The new vessel is of all-welded steel construction, built to a design proven to be successful and very popular with the U.S. Army Corps of Engineers, who have many similar boats in service.

Principally, the vessel is 53 feet long, with a 14-foot beam drawing 4½ feet of water, powered by twin Detroit 671 engines, and having a 10 KW Waukesha diesel-powered generator supplying AC power at 220/110 single phase, in addition to which DC power in the 8 volt, 12 volt, 24 volt, and 32 volt ranges is available through main engine-driven alternators, converters and battery banks.

In addition to a spacious wheelhouse and particularly well-found crew quarters forward, the vessel has 378 square feet of clear working space on the aft deck, broken only by a towing bollard, the entire aft deck being maintained flush as all



Original dive tender SHARK now up for disposal through Crown Assets

compartment hatches are of the flush type, while an 18" high bulwark surrounds the deck.

The addition of an HIAB articulated hydraulic crane and a hydrographic winch made for an extremely versatile survey craft, while her draft, one foot less than her predecessor, allowed her to operate in shallower waters on shore.

## GREAT LAKES BIOLIMNOLOGY LABORATORY

### Surveillance

*Nutrient-Related Studies*

The cooperative work carried out with the EPS Wastewater Technology Centre on the bioavailability of phosphorus from sewage treatment plants was completed. The results were inconclusive in themselves, but were felt to point the way to further research. This is now being carried out under contract to Environment Canada.

Three research cruises were launched in 1980. The object of these was the investigation of the role of light and temperature as opposed to nutrients in the productivity of Lake Superior. Results published so far indicate that the role of physical factors is far more important than had originally been supposed. The implications for phosphorus management could be significant. Further work is being carried out in 1981.

Phycological studies centred on the completion of the ten-year analysis of Lower Lakes phytoplankton data. A report to IJC on this study has been prepared.

A thorough workup of the data collected on Lake Huron in the early seventies was completed in time for presentation of a major paper on Great Lakes phytoplankton at the S.I.L. Congress in Kyoto, Japan.

Work on the role of nannoplankton in the Great Lakes phytoplankton community continued, with both field and laboratory experiments on the impact of metal mixtures on natural populations.

### Contaminant Surveillance

*Contaminant-Related Studies*

Efforts were continued to maintain a data base to predict trends in toxic substance concentrations for Great Lakes biota. Further emphasis on the surveillance of contaminants in fish, plankton and benthic invertebrates was directed towards the Upper Lakes. Fish samples were collected and analyzed from sites in both Lake Huron and Lake Superior. An initial three-week sampling cruise aboard the CSL SHARK monitored levels of trace metals and persistent organic compounds in water, plankton and benthos samples from five sites in Lake Huron and Georgian Bay.

Data derived from the annual Contaminants Surveillance Program were utilized in preparing submissions to the IJC Aquatic Ecosystems Objective Committee and the annual Water Quality Board Report.

A laboratory technique developed to measure the biochemical response of fish exposed to waterborne concentrations of lead was applied to field-oriented contaminants surveys. The inhibition of the enzyme erythrocyte δ-amino levulinic acid dehydratase (ALAD), indicative of an **exposure** to lead, was measured in several species of fish from the Lower Great Lakes and the St. Lawrence River. Members of the Environmental Toxicology and Contaminants Surveillance Sections measured enzyme levels throughout the year in several species of fish representing various trophic levels collected from contaminated and uncontaminated sites. The outcome of the study will be the determination of the effect of trophic level, waterborne lead concentrations and season on enzyme (ALAD) activity. Thus, the utility of this biochemical response as an environmental stress indicator can be validated for field surveys.

Results of a survey to determine the occurrence of organolead compounds in several species of Great Lakes fish were analyzed in 1980-81. The highest incidence of organolead occurred in samples of both top predator and forage fish species from Lake Ontario, while the lowest occurrences were observed in forage species from Lakes Erie and Huron.

*Tissue Bank*

Previous tissue bank studies indicated significant losses of HCB, p,p¹-DDE and PCB from whole fish homogenates when freeze-dried or stored at -20°C. An additional study was initiated to assess the losses of organic compounds from fish homogenates stored at -40°C compared to storage at -20°C. Analysis of samples stored under these conditions for a period of one year is complete, and statistical evaluation of the data is now underway. Additional tissue bank studies have been initiated to determine the effect of storage temperatures of -80°C and -196°C, as well as the effect of formalin preservation and the extraction method on PCB concentration in various fish tissue samples. Current archiving studies with zooplankton samples indicate that storage temperatures of -30°C or +20°C after oven drying at +60°C result in similar losses of chlorinated hydrocarbons.

*Tumour Monitoring*

A fish tumour-monitoring program was initiated in April, 1980 to determine if tumour incidence could be used successfully as a surveillance tool to identify fish populations which were responding to stress, particularly contaminant stress. The development of suitable criteria for measuring stress will provide a means of assessing the health of fish from selected sites in the Great Lakes, an early warning of deteriorating environments, and an opportunity to link laboratory cause and effect studies with field observations.

Tumour incidence was recorded for at least three species from twenty-seven sites on the Lower Lakes. Approximately eight thousand fish were dissected during the survey. Preliminary results suggest the white sucker *(Catostomus commersoni)* is an excellent indicator species. The sucker exhibits an anomaly in the form of a lip papilloma which is

Staff of Great Lakes Biolimnology Laboratory

readily discernible under even casual observation (Figure 12). The frequency of occurrence appears to be site specific, with the highest frequency (32%) found in Hamilton Harbour. The fish are easily obtained during the spawning migration and are available from most sites on the Great Lakes. Studies are underway to determine the value of the lip papilloma as an indicator of stress by comparing tissue residues, somatic indices, reproductive potential, and specific organ histology between tumour bearing and non tumour bearing fish.

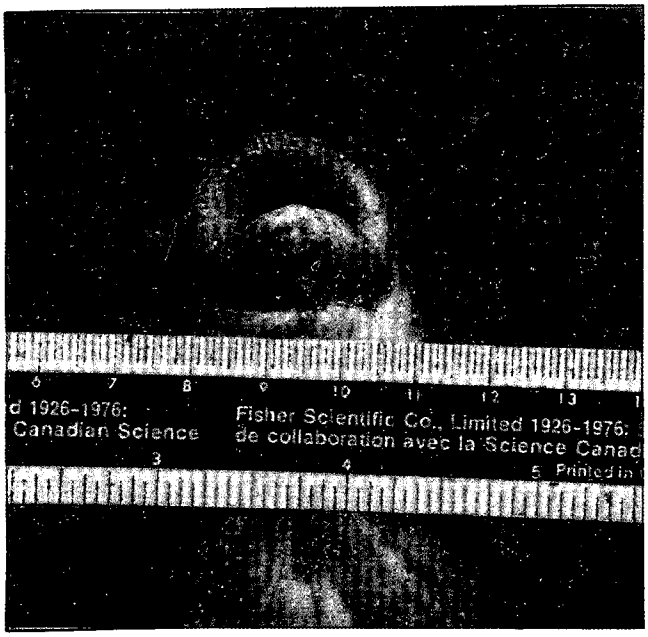



Figure 12. Papilloma on the lower lip of a white sucker *(Catostomus commersoni)*

*Lake Trout Reproduction*

Lake trout populations, once plentiful during the first 30 years of the 20th Century, dwindled and collapsed during the period from 1935 to 1950. The causes are numerous; overfishing, lamprey predation, and changes in species composition are commonly believed to be main factors responsible for the near extinction of lake trout in Lake Ontario.

Since the mid 1950s restoration and rehabilitation of the lake trout populations has been a major objective of both the provincial and state fisheries agencies. The Ontario Ministry of Natural Resources and the New York Department of Environmental Conservation stocked approximately 3.5 million lake trout in Lake Ontario between 1973 and 1978 in an effort to reestablish a viable, self-sustaining population. New York has recently achieved their objective of planting one million lake trout yearly into Lake Ontario.

The success of this program depends, in part, on the ability of these animals to reproduce. In 1978, New York reported an anomaly in lake trout testes which appeared as a constriction at irregular intervals along the testes (Figure 13).

Several testes were examined histologically by Dr. Sylvia Ruby from Concordia University. The

Figure 13. Typical anomaly in the testes of four-year old lake trout *(Salvelinus namaycush)* from Lake Ontario.

results, from a very small sample size, suggest that fish with gonad anomalies show delayed cycles of spermatogenesis, collapsed seminiferous tubules, and a reduction in the amount of sperm available for fertilization.

The Ontario Ministry of Natural Resources has provided information on the geographical distribution and frequency of occurrence. Almost fifty percent of the male lake trout in Lake Ontario show evidence of this condition; forty-two percent in Lake Huron (from the Great Lakes Fishery Laboratory, Ann Arbor, Michigan) and twenty percent in Lake Superior. The anomaly is present in native and hatchery fish, and a similar condition has been observed in splake backcross, herring and whitefish.

The implications of this anomaly to successful rehabilitation of the stock are unknown. Further histological analysis is underway to verify the initial findings.

## Environmental Toxicology

### Contaminant Effects on Biota

*Metals*

Studies on the effects of a mixture of metals on freshwater phytoplankton indicated the degree of synergistic and antagonistic toxicity of various combinations of metals. One metal that exerted the most toxic effect at the recommended IJC Water Quality Objective level was zinc. It is, therefore, suggested that the current water quality objective for zinc be reduced to one-tenth of the present recommended level.

Some factors affecting the toxicity of metals on the biomass production rates of freshwater copepod

populations were investigated. The impact of both strong and weak complexing agents on metal toxicity and the shape of the toxicity curve were studied. Much of the seasonal variation in metal toxicity, and the differences in toxicity in Lake Ontario versus Hamilton Bay waters appeared to be related to the presence of organic complexing agents in the water. Inorganic complexing agents (carbonates and hydroxides) appeared to be relatively unimportant, and hence pH had little or unexpected effects (i.e. reduced toxicity at lower pH) on metal toxicity.

Research done on contract to GLBL by Dr. D.G. Dixon and Dr. J.B. Sprague at the University of Guelph showed that the rate of appearance of symptoms of chronic lead toxicity by young trout exposed to lead was a function of fish growth rates and not of fish size.

The toxicity of alkyl lead compounds to fish was also examined in field and laboratory trials. A cooperative study with the Ontario Ministry of Environment of an effluent containing alkyl lead compounds was designed to continuously expose young rainbow trout to various dilutions of effluent pumped directly from the discharge pipe. However, water quality problems in the dilution water killed all fish and the experiment failed. A laboratory study of tetra ethyl lead, however, showed that the 2-week LC50 for rainbow trout was between 10 and 30 $\mu$g/L and that significant chronic toxicity was evident at concentrations close to 0.2 $\mu$g/L.

*Organic Compounds*

The relationship between structures and toxicity of triaryl phosphates (a widely used plasticizer) on algal primary productivity was examined. In general, the triaryl phosphates were very toxic to algae with tri-o-tolyl the most toxic, followed by trixylyl and tri-p-tolyl phosphates. The algae used for the experiments were pure cultures as well as natural phytoplankton from Lake Ontario water.

Dr. George Dixon joined GLBL from the University of Guelph as a post-doctoral fellow and initiated studies with fish of structure-toxicity relationships of two classes of compounds: chlorinated benzenes and para-substituted phenols. In cooperation with Dr. K.L.E. Kaiser, NWRI, the short-term acute lethality, tissue distribution and sublethal effects of 27 compounds is being evaluated. Progress in 1980 included completion of a literature search and initiation of the lethality and tissue distribution studies.

Studies on mixed function oxidase activity in invertebrates were also conducted.

**Contaminants Dynamics**

*Metals*

As there is strong evidence that methylation of lead, similar to mercury methylation, occurs in the environment, studies were initiated to determine the mechanism of lead methylation, as well as the occurrence of methyllead compounds in aquatic biota.

Studies of chemical methylation of lead indicated that methyl iodide, a chemical in natural waters, could methylate inorganic lead compounds to tetramethyllead. This finding is significant because tetramethyllead is a known and extremely neurotoxic compound. Its occurrence would have serious consequences for water quality and for the well-being of aquatic biota.

Occurrence of lead methylation in the aquatic environment was supported by the findings that a number of fish samples from lakes and rivers in Ontario contained various methylated lead compounds. Even though the concentration of these methylated lead compounds was low, representing less than 10% of the total lead, the much higher toxicity of these compounds made their occurrence in fish important.

The spatial, temporal, and species variation in lead content of Lake Ontario fish was measured in a survey conducted with surveillance. The purpose was to evaluate the effectiveness of an enzyme as an indicator of lead exposure in fish. The enzyme, erythrocyte $\delta$-aminoevulinic acid dehydratase (ALAD), has been shown in previous laboratory studies to be readily inhibited by lead exposure of fish. The data generated are currently being analyzed to meet the above objectives.

*Organic Compounds*

Studies on the kinetics of hexachlorobenzene (HCB) in fish have been completed. HCB was persistent once ingested; feeding studies using rainbow trout suggested that 80% of HCB was retained for periods greater than 7 months. Integration of the results of laboratory studies and measurements of HCB levels in Great Lakes biota and waters suggests uptake of HCB by salmonids is primarily through food intake. Laboratory studies have also demonstrated that fish can accumulate HCB at concentrations substantially higher than those monitored in Great Lakes fish. Availability of HCB in the Great Lakes environment may be a limiting factor in maintaining HCB levels in Lake Ontario salmonids at 40-100 $\mu$g/kg.

Research was completed on the fate of $^{14}$C-labelled PCB (Aroclor 1242) attached to clay particles and added to model planktonic ecosystems. Several experiments were conducted on the effects of algal and clay particle abundance and strength of vertical mixing on the losses of PCB from the water column due to volatilization and sedimentation. Volatilization losses are inversely related to particle density because of the same relationship between the size of the soluble pool and particle density. As a result, sedimentation losses are favoured at higher particle densities. A computer simulation model has been developed that accurately describes the changes in total PCB concentration observed in all experiments. Future experiments will compare the

fate of different compounds such as Aroclor 1254 and HCB to that predicted by the model developed for Aroclor 1242, taking into account differences in adsorptive properties and vapour pressure. Contract work on release of PCB from sediment and uptake by benthic organisms such as amphipods and sculpins was also funded.

**Other Activities**

As part of the Environmental Assessment Review Process, the fisheries and aquatic sections of the proposals submitted for the Eldorado Nuclear Refinery Plants at Port Hope and Blind River, Shoal Lake Cottage Development, Turkey Point Marina Development, and Port Maitland Development Projects were reviewed for possible environmental impacts. There was also considerable input to the report of the Aquatic Ecosystem Objectives Committee of the International Joint Commission. A new lead objective recommended by this committee relied very heavily on lead research by GLBL.

**Ecosystem Studies**

The year 1980 saw a continuation of Project Quinte into its ninth year, and the initiation of Acid Rain studies in the Turkey Lakes Forest Watershed near Sault Ste. Marie, and in the Georgian Bay/ North Channel Region of Lake Huron.

*Long Range Transport of Atmospheric Pollutants*

In April a major helicopter survey was carried out to establish the extent of the spring melt upon sensitive headwater lakes in the Sault Ste. Marie district. This was followed by extensive field work through the spring and summer. Additional surveys of other stressed lakes in the Sault Ste. Marie and Georgian Bay area were made.

Baseline information on airborne organic contaminants was obtained from two lakes near Tobermory on the Bruce peninsula. Concentrations of a wide variety of organic chemicals were obtained from samples of precipitation, lake waters and sediments, selected species of fish, crayfish and molluscs.

A major field program in Georgian Bay/North Channel was carried out from the newly-opened Owen Sound office. Benthic samples and open water samples were collected from about 200 stations.

The Owen Sound unit collaborated with the Ministry of Natural Resources' staff at its Research Station on South Bay, Lake Huron. Collections of benthos will be used to assess production of selected fish food organisms important to fish in South Bay.

Streams interconnect four lakes of increasing pH and alkalinity in the Turkey Lakes forested watershed. Streams were examined from spring to fall and collections were made of stream fish, stream invertebrates and attached algae. In each of the four lakes, programs were completed to examine community and production amongst phytoplankton, benthos, fish, and, in part, aquatic macrophytes. Techniques ranged from use of radioactive tracers for plankton production to conventional population dynamic approaches for benthos, macrophytes and fish. All examinations were conducted in the entire ice-free period.

As part of DFO's program to establish effects of acid rain upon eastern Canadian sensitive fisheries, the headwater lake sampling program was extended across Ontario to cover 105 lakes in five zones of differing deposition. The techniques developed in 1979 were applied to examine community success for benthos, phytoplankton, zooplankton and fish communities, while describing lake acidity status and fish body burden. Further, in order to examine an overview of the Ontario fishery response to acid deposition, the OFIS data base was examined through contract.

*Quinte 1980*

Five stations in the Bay of Quinte were visited weekly, employing the launch AQUA from May to September inclusive, and two others weekly during June and August only. Sampling for nutrients, algae, zooplankton, primary production, light extinction, temperature and dissolved oxygen was carried out. Primary production rates and chlorophyll *a* concentrations declined in 1980 to levels observed in 1978, the lowest since the inception of the project in 1972. Compared to the prephosphorus removal period (1972-1977), the seasonal average for the light-saturated primary production rate for the 1978-1980 period has declined 45% and 33% at Belleville and Deseronto, respectively.

Dr. J.R. Vallentyne, Senior Scientist, Fisheries and Oceans, has proposed global adoption of a World Decade of the Biosphere to improve public, scientific and political focus on measures for safeguarding our Biosphere. Symbolizing this need with a 30-centimetre globe on his back, Dr. Vallentyne transmitted the message to newspaper and television audiences numbering in the millions in Canada, Japan, Denmark and the United States.

*CALYPSO: A Visiting World Traveler*

There's no name painted on the white, wooden hull of explorer Jacques Cousteau's ship, CALYPSO, but she's instantly recognised by television audiences around the world.

That's why a flotilla of small boats waited and crowds lined the shore one sunny Sunday afternoon last fall as the famous research vessel arrived at CCIW, on her first visit to the Great Lakes.

Tom McCulloch (A/D.G. Central Region), Jacques Cousteau and Jack McDonald, Mayor of Hamilton, Ontario on R.V. CALYPSO.

It was a working trip, and her stay in port was short, yet an estimated 5,000 people showed up at the Canada Centre for Inland Waters for a close-up, dockside look at the marine adventurer.

Smaller than many of the spectators expected, CALYPSO is a former British minesweeper, with an overall length of 43 metres and a 7.6 metre beam.

She was built in Seattle in 1942, served in the Second World War, and then became a ferry in Malta before Capt. Cousteau converted her for oceanographic research.

Powered by diesel engines which give her an average speed of 10 knots, CALYPSO has made more than 50 expeditions in the last 30 years, ranging as far as Antarctica, but never before on North America's inland fresh water seas.

Although registered in Toulon, France, CALYPSO makes her home now in Norfolk, Virginia, operations base of the Cousteau Society, which joined with Canada's National Film Board to sponsor the 1980 voyage up the St. Lawrence and through the lakes.

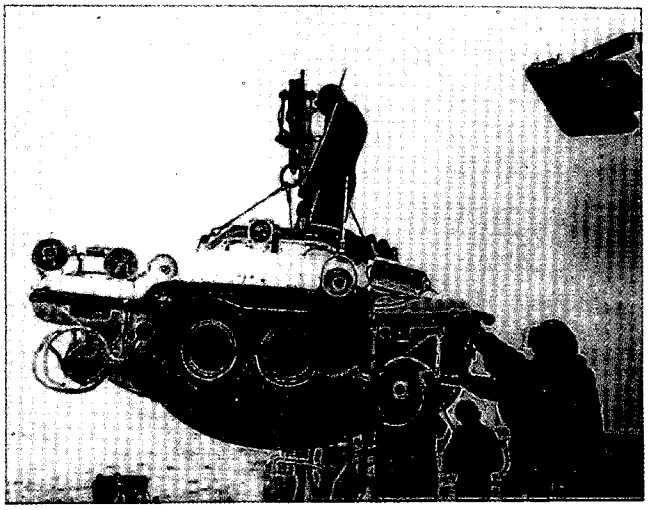
CALYPSO stopped at the head of Lake Ontario to make plans for a dive to film the U.S. warships, HAMILTON and SCOURGE, sunk in a storm 167 years ago, during the War of 1812.

Title to the two ships, lying intact in nearly 90 metres of water, has been given to the City of Hamilton, which hopes to raise them for display in a museum to be built at Confederation Park.

Located in 1975 by CCIW hydrographers, scientists, and Dr. Dan Nelson, an amateur underwater archaeologist, the two historic vessels had been pinpointed with sonar and glimpsed through an underwater TV camera, but no one had been down to the site or obtained clear pictures.

Attracted by the unique opportunity, the Cousteau team enlisted the aid of CSS LIMNOS and CSL SHARK and a team from CCIW to locate and buoy an anchoring system to enable CALYPSO to position herself over the wrecks.

Short of time and hampered by poor visibility underwater, CALYPSO'S two-man diving saucer managed to explore only the HAMILTON. Even so, the film is expected to be a highlight of the resulting TV programs next season.



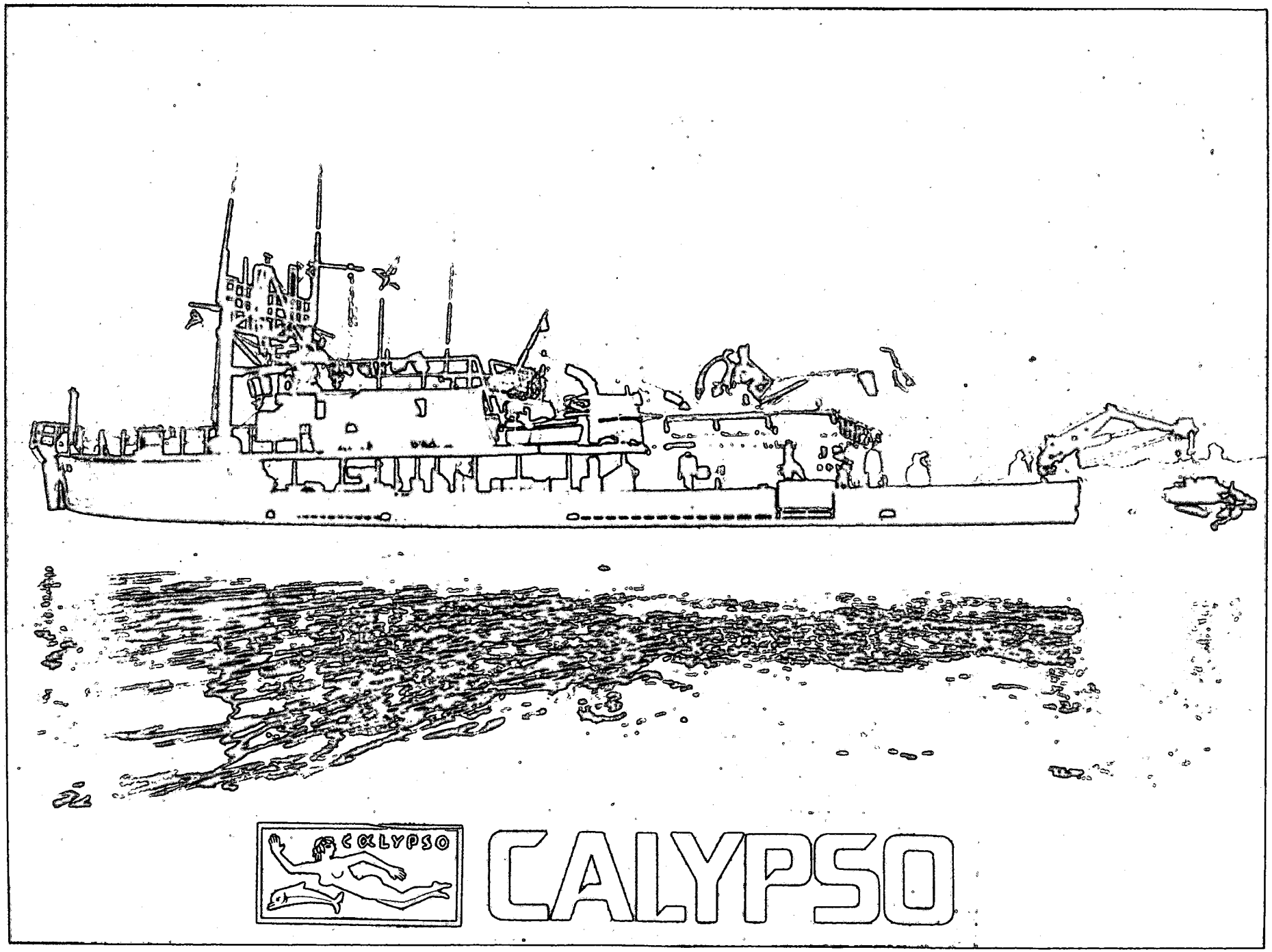
The soucoupe (saucer) being lowered.

Albert Falco, Cousteau's chief diver, said he had waited 30 years to be the first to see something as dramatic as the sunken warship.

Both Mr. Falco and Dr. Nelson described a beautiful carved figurehead of the goddess Diana, and cannon still standing ready on the deck.

Dr. Nelson said the ship "looks like it was just set down gently on the bottom of Lake Ontario." The sails and rigging have disintegrated, but the masts still stand tall and the wood appears sound.

After her work on the lakes was finished, CALYPSO spent some time amid early winter conditions on the Gulf of St. Lawrence before returning to Norfolk. Her next expedition will likely be to another major river system — the Amazon.


CALYPSO
CALYPSO

## REGIONAL MANAGEMENT SERVICE

**Regional Management in Review**

During 1980 the Region expended the following resources:

*000's*

| Person Years | Salaries | Operational $ | Capital | Total |
|---|---|---|---|---|
| 201.5 | 5,120 | 2,940 | 542 | 8,602 |

$680,000 was spent on behalf of other Federal/Provincial departments. Regional vehicles covered 667,291 km while performing their assignments with an accident frequency rate of 0.48 per 160,930 km.

Regional Materiel Management is engaged in the preparation, packing and shipping of equipment, materials and supplies for field parties, primarily in the high Arctic. One hundred thirty-eight tons were shipped.

Surplus and obsolete equipment values originally at $110,546 were disposed of by Crown Assets.

The Accounting and Procurement Sections were renovated and co-located to allow for greater efficiencies in both paper flow and communication.

The Regional Personnel Office provides a service to both Ocean Science and Surveys and Ontario Region of Pacific and Freshwater Fisheries. An additional professional position was identified to respond to Staffing, Human Resource Planning and Development requirements. The office processed 142 staffing requests and 123 Classification Action requests.

Mr. B.J.T. (Terry) O'Hagan, Chief of Finance & Administration, retired from the service after 7½ years with the government. He had 25¾ years with the Canadian Armed Forces prior to joining the department.

## PUBLICATIONS AND PRESENTATIONS

### Hydrographic Division

#### Publications

Casey, M.J. The Field Sheet as an inefficient Medium. Journal of the Canadian Hydrographers' Association, LIGHTHOUSE, Edition No. 22, November, 1980.

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Lewis, R.C. The Weed Dilemma. Proceedings of the 19th Annual Canadian Hydrographic Conference, 1980.

Macdonald, G.D. NAVBOX — Straight Line Navigation and On-Line Data Filtering on Hydrographic Surveys in Canada. Proceedings of the National Ocean Survey Hydrographic Survey Conference, 1980.

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Marshall, R.A. The Nautical Chart. Presented to the Canadian Power Squadrons, York East Division, Ontario. April, 1980

### Research & Development Division

*Internal*

#### Technical Note Series

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Brooks, D.J. *James Bay/La Grande Winter Oceanographic Survey. 1980 Field Report,* Field Report Series No. 80-1. Central Region, Ocean and Aquatic Sciences, Department of Fisheries and Oceans, Burlington, Ontario.

**Special Reports**

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Freeman, N.G. Winter Oceanographic Survey in James Bay. Article prepared for FMS News. March, 1980.

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