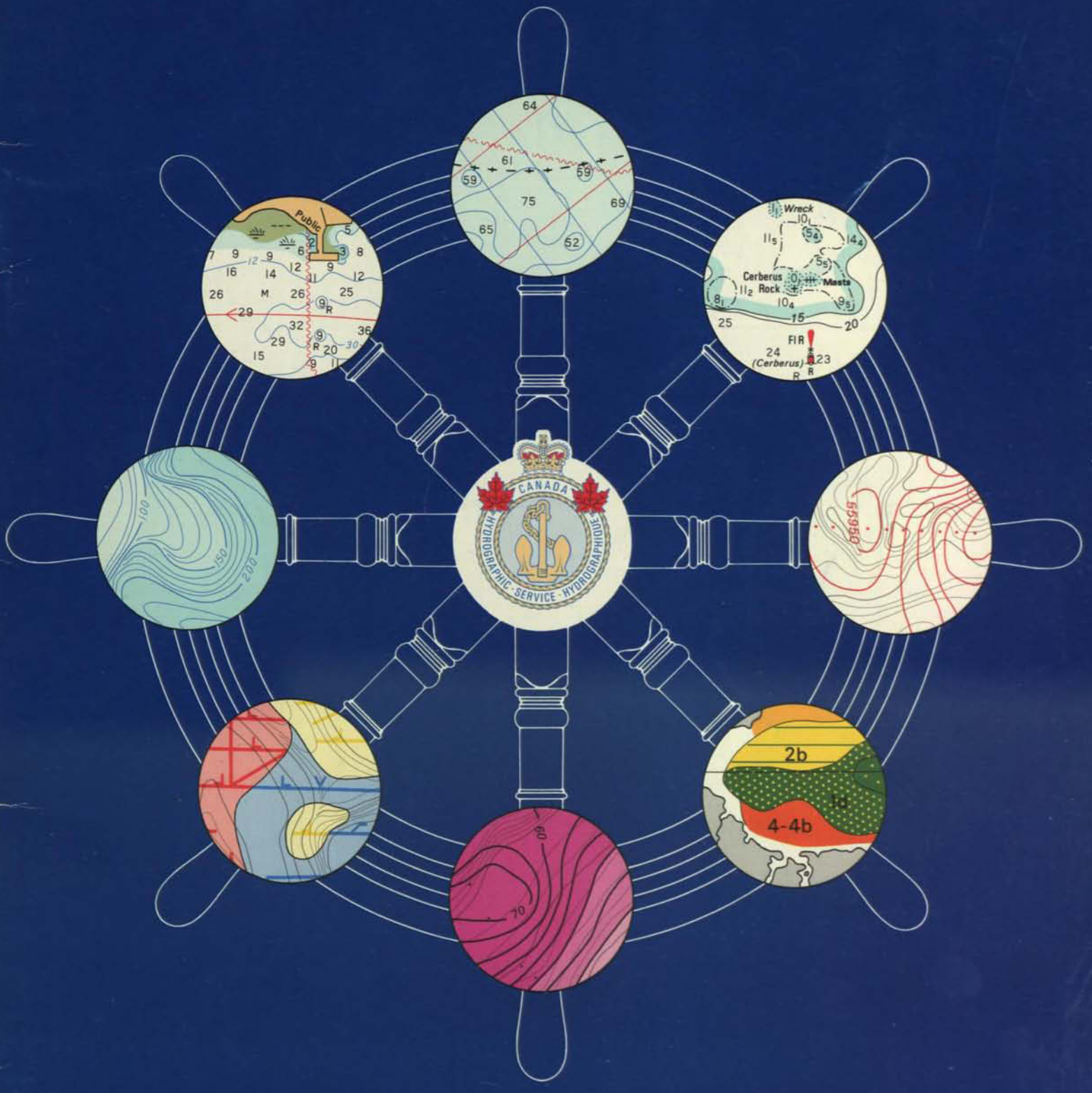
1973



Canadian Hydrographic Service **Service hydrographique du Canada**

Canadian Hydrographic Service

Annual Report 1973

Contents

Introduction

CANADIAN HYDROGRAPHIC SERVICE

Background

The charting of navigable waters is essential to the development of a viable, safe, and efficient marine transportation system. The first charting of Canadian waters was carried out by early Spanish, French, and English explorers. After Canada became a colony of Britain, detailed charting was carried out by the British Admiralty. In 1904, the Admiralty requested that self-governing colonies assume responsibility for their own coastal surveys because of an anticipated need to bolster the home fleet which was facing a fast-growing naval power in Germany.

Although Canadians had carried out some surveys since 1883, these survey activities were conducted by individual departments as required to meet their own needs.

The authority for the Canadian Hydrographic Service is contained in Order-in-Council P.C. 461 of 1904 which brought together all hydrographic activities of the departments of Public Works, Railways, and Canals and transferred the responsibility to the Department of Marine and Fisheries. The service has survived 10 changes of name for senior echelons to arrive back, intact, under the present umbrella of Fisheries and Marine.

Objective

The Canadian Hydrographic Service is primarily concerned with gathering and publishing bathymetric data and marine navigational information on Canada's navigable waters and adjoining international waters. This information is essential to the safe, orderly, and efficient conduct of commercial, recreational, and defense shipping. Of growing importance is the operational responsibility for integrated geophysical hydrographic surveys of the continental margin and inland seas. Such surveys are essential to obtain a comprehensive description of the extent of the continental land mass and for the control, management, and development of mineral and petroleum resources in these areas.

Policy

The gathering of data is carried out by three regional hydrographic divisions of the Marine Sciences Directorate operating from the Bedford Institute of Oceanography, the Canada Centre for Inland Waters, and the Victoria, B.C., office. The Canadian Hydrographic Service headquarters (Hydrography Branch) in Ottawa acts in a functional capacity with the regional divisions, charged with the responsibility to monitor the quality of data, establish standards, conduct training and career development programs, coordinate survey programs, and establish national priorities.

Most survey programs are carried out using the Marine Sciences Directorate fleet of ships. However, many arctic programs are conducted on an opportunity basis from CCGS icebreakers of the Ministry of Transport, and through the logistic facilities of the Polar Continental Shelf Project.

The compilation, drafting, and distribution of nautical charts and associated publications are carried out by the Hydrography Branch with the exception of some compilation and distribution with a limited publication facility maintained in the Victoria office. Nautical charts and publications are available through 375 dealerships established around the world with the majority in North America; in Canada 292, and the USA 56. Notices to Mariners, a joint publication with the Ministry of Transport is distributed without charge by Information Canada.

At present, the Canadian Hydrographic Service has 179 field staff members in the regions and 168 in Ottawa Headquarters.

ADDRESS BY THE DOMINION HYDROGRAPHER TO THE THIRTEENTH ANNUAL CANADIAN HYDROGRAPHIC CONFERENCE

Mr. Conference Chairman
Our Hosts
Distinguished Visitors
Ladies and Gentlemen

It gives me great pleasure to have again been asked to address this annual meeting of Canadian hydrographers. The meeting over the past few years has become a joint undertaking of the Canadian Hydrographic Service and the Canadian Hydrographers Association. I think I am correct in saying that this kind of meeting is unique in the world hydrographic community. Perhaps this is because of the tremendous geographic extent of this country and the consequent necessity to regionalize our activities to bring about an effective operational thrust in surveying our extensive internal water systems and the three great oceans that form the second longest coastline of the world.

I rather like to think, however, that what makes this conference thrive and improve each year is a new awareness on the part of hydrographers of the tremendous importance of the services they perform and the enormity of the job that is to be done in the interests of safe navigation and the basic mapping of the huge area of our continental landmass lying beneath the open waters of our east and west coasts and the ice-covered waters in the north. This challenge alone is sufficient to develop the necessity for gathering together occassionally to discuss new ideas, methods of approach, techniques, requirements, and of course new developments that may make our task an easier one.

Add to this national requirement our growing obligations in the international community to provide equipment, training, and surveying expertise to developing countries, in order that they may eventually establish an independent hydrographic capability — our ongoing commitment to the General Bathymetric Chart of the Oceans, our acceptance of the responsibility to produce three of the new 1:3,500,000 International Small Scale Charts, and a further commitment to assist in the preparation of a fourth — and of course we are all familiar with the controversy that has developed from the Charts and Publications Regulations of the Canada Shipping Act. On the latter subject I would only like to mention that Canada has officially responded to the criticisms lodged by foreign agencies and/or organizations through diplomatic channels. We have, however, deliberately refrained from engaging in public debate through comment in the International Hydrographic Bulletin and/or shipping–navigation magazines in which articles have appeared. This position was taken because of my conviction that such journals are not the appropriate forums in which to debate Canadian national legislation nor the internal legislation of any other sovereign state.

We have recently submitted a brief for publication in the International Hydrographic Bulletin. The brief outlines a proposal for the establishment of an International Chart Publication and Distribution System at medium and large scales. As I am sure this topic will come up in formal or informal discussions during this conference I have brought several copies of our brief along with me and for any of you who would like to read it there are copies available in the reception area.

The growing representation at this annual conference of industry, other Canadian government agencies, and guests from the national hydrographic offices of many countries is of course another measure of the conference fulfilling a very useful purpose in the exchange of ideas that will hopefully help all of us to solve our existing problems, to cope with present obligations, and to meet the challenges of the future.

When outlining topics to discuss during this talk, I thought it would be an easy task to review some of the highlights and new endeavors of the past year within the Service but, with a little review it proved to be a much more involved task than I anticipated. The list of talks presented and papers submitted for publication by members of our Service contains too many topics to mention each individually. I also found the number of new projects and development activities being undertaken in the regions and headquarters as described in the submissions for our Annual Report was far greater than I expected.

Maybe I could begin by stating that the Annual Report is a new project in itself. It is intended that each year we shall prepare a reasonably comprehensive report of our total Canadian Hydrographic Service activities, to serve as an informative document for senior management, a digest of current events in hydrographic circles, and of course as an historical record of significant achievements, personnel and organizational changes, and so forth. Initially it was hoped that this report would be available for distribution this year at the annual conference; however, I allowed insufficient lead time for it and elected to have it completed for a later date rather than hurrying it to such an extent that we put out something less than a first class publication. In future years, when format, style, and earlier submissions are put in order, I would like to have it available for tabling at the Annual Conference.

A notable first time ever for us this year is the conduct of a major hydrographic survey for a

developing nation and the training of two foreign students in the techniques and methods of hydrographic surveying. This survey is presently being carried out in the offshore area of Guyana and in the approaches to its main harbor, Georgetown, at the mouth of the Demerara River. The operational part of the survey is being carried out from the CSS *Baffin* under the capable leadership of Bert Smith of the Atlantic Region and is providing a field training opportunity for eight Canadian and two Guyanese hydrographers. The funding for a large part of the operation has been made available from the Canadian International Development Agency who has provided some $300,000. This amount roughly represents the difference in expense between laying the *Baffin* up for the winter months and having it operational. I am told that the survey is going well and that we will meet our objectives. Hopefully similar arrangements for other surveys can be agreed upon in the future.

Internal development activities are progressing favorably as can be noted from the evaluation reports published in the I. H. Bulletin; such as An Evaluation of the Trisponder Positioning System, Model 202A and A Canadian Test of the Motorola Range Positioning System with a Low Gain Ommi Directional Antenna, both by Tony Mortimer. Other significant papers either published or in press include articles on the Bo'sun Multi-Beam Sonar evaluation by Bob Burke and John Robson; evaluation of side scan sonars and tests of LORAN-C by Rick Bryant, Earle Brown, and others, and an outline of the Telemetric System used by the Tides and Water Levels unit of the CHS by Gerry Dohler. In the navigation area there is the excellent paper by Steve Grant on Rho-Rho LORAN-C combined with satellite navigation. The new experiments on propogation velocity of E/M waves over ice-covered waters will be reported upon in the near future by David Gray and others and will provide additional information to the original work done by Dave Wells and Paul Brunavbs. Mike Eaton is continuing his excellent work with navigation systems generally and has recently prepared a detailed submission on establishing a LORAN-C station on the north shore of the Gulf of St. Lawrence that could have a profound effect on coastal and offshore navigation for both Canada and the United States. Mike's study came about from a suggestion by an officer of the Canadian Armed Forces, Capt Mel Walker, who was with the Defence Research Establishment Atlantic and is now stationed with the Canadian Armed Forces in Winnipeg.

Work is continuing on the Aerial Hydrography Project that was initiated by Neil Anderson and is being carried out at the Canada Centre for Remote Sensing in Ottawa by John Watt and his assistant, who have been seconded to the project from the Pacific Region. Favorable progress is also being made in development work on Automated Cartography under Hiro Furuya. This year they have developed a relatively unsophisticated sounding selection program that appears adequate for smooth or gently undulating topography, but is not yet sufficient for extremely rough topography containing numerous shoals.

I would like also to bring to your attention the fact that two of our regional hydrographers, Mike Bolton and Russ Melanson, have been asked to take charge of the scientific program on two of the three phases of Canada's participation in the GARP Atlantic Tropical Experiment, a major multinational program of the Global Atmospheric Research Program. Our third Regional Hydrographer, Adam Kerr, is heading up the Marine Cartography Committee of the International Cartographic Association and has his hands full preparing for their major conference in Madrid this coming April. These many involvements on the international scene and our commitment to major participation in FIG and the Commonwealth Survey Officers Conference makes the Canadian Hydrographic Service extremely visible. But one must remember that when you become visible you can also become vulnerable, expecially in the sense that an error is much more conspicuous than an additional achievement. I would, therefore, caution that we continue to devote adequate attention to the quality of our products, whatever they may be, to ensure that they can survive the most critical examination.

I would like now to devote the remaining portion of my talk to outlining a few significant changes that will be taking place within the organizational structure of the headquarters element of the Canadian Hydrographic Service. First, most of you are aware that Ottawa headquarters has a functional relationship with the Regional Offices rather than a line control. In other words we are responsible for setting standards, establishing national priorities, coordinating programs especially where other departments are involved, and of course we are charged with the overall responsibility to see that the mariner is adequately served. In addition to this, Ottawa looks after the compilation, drafting, and printing of charts, sailing directions, tide tables, and so forth from the field work that is turned in from the regions. The Pacific Regional Office is somewhat different in that it looks after compilation in that region and also does a great deal of work involving sailing directions, tides and tidal current projects. In the near future it is anticipated that they will take the further responsibility for final drafting and printing of certain selected charts in their own area. Major changes have taken place over the past 15 years or so, such as (1) regionalization, (2) automated cartography

(which has made some routine drafting functions obsolete), (3) new methods in production systems design and control, (4) our growing involvement in geoscientific interpretation of bathymetric data, (5) the changing guidelines for GEBCO, (6) our publication of new products such as the National Resource Series of maps and fisheries charts. All of these happenings and many others have dictated the need for a major reshuffling of our organizational structure to meet the new demands more or less within our existing resources of manpower and money.

The new organization attempts to bring compilers and draftsmen together to work in a team approach to chart construction. Chart construction teams will be assigned to a chart area of responsibility corresponding to the regional survey responsibility. It is hoped this grouping will bring about a closer identity of the team with the chart product but also a closer liaison with the Region with which they are associated and a better knowledge of the total requirements of the Region. It should also facilitate exchange assignments to field establishments so that the chart makers become more familiar with their areas of responsibility and, in turn, the field hydrographers will gain a greater awareness of difficulties encountered in chart construction. Another feature of the new Chart Production Division will be a production control unit that will be responsible for the scheduling and expediting of work through the different service areas such as automated drafting, nomenclature, reprographics, and so forth.

A second division will be responsible for Planning and Development. The emphasis for planning here will be comprehensive hydrographic planning for charting requirements, charting schemes, surveying requirements, surveying specifications based on a national assessment of priorities. Training will also come within this division and again training is intended to be comprehensive in scope, developing training and career development programs for compilers, draftsmen, and surveyors. The Division will also be responsible for the establishment of standards in both cartographic and survey work. A major change will be brought about by having the Automated Cartographic Unit shifted to the production division, with a new unit established in Planning and Development that is primarily concerned with the development of new graphic products primarily through computer cartography and new illustrative techniques. This development unit will also have the responsibility for specialized graphics, national resource maps, fisheries charts, and other new products.

A third division will be responsible for navigational publications such as sailing directions, tide tables, technical records, chart distribution, chart corrections, notices to mariners, and so forth. In this area it is intended to develop a better market awareness than we presently have, but essentially it is really only a relocation of some units that already exist in the hope that these units with a common purpose will be able to provide a more efficient service.

With the new organization, I have provided for a staff assistant and also an Hydrographic Bureau Affairs Officer — those two positions should be classified and staffed in the near future. The prime job of the staff assistant over the next year or two will be to bring the new organization into being.

I would like at this time to acknowledge my sincere appreciation to Colin Martin, who resigned on December 27, 1973, from the post of Assistant Dominion Hydrographer. He was a tower of strength for me during my first 2 years in this office and prior to his retirement he contributed significantly to the design of the new organizations structure that I have just described. He remains a very close friend and I am sure he is available in the wings to assist any one of us in the future. He has in his 35 years of service contributed greatly to the well-being of this organization and we owe him a tremendous vote of thanks.

In closing I would like to extend my own thanks and appreciation to all of you within the Service who have made 1973 another very successful year.

Thank you.

G.N. Ewing
Dominion Hydrographer
Canadian Hydrographic Service

Hydrography Branch

TERRITORIAL WATERS SECTION

The Territorial Waters Section continued to provide an advisory service on hydrographic and related matters to the Department of External Affairs.

Eighteen months development work and a close liaison with the Danish Hydrographic Office contributed to an agreement, signed in Ottawa December 17, 1973, between Canada and Denmark delineating the Continental Shelf boundary between Greenland and the Canadian arctic.

In preparation for the 1974 Law of the Sea Conference, research work, including multidisciplinary studies carried out in conjunction with the Interdepartmental Committee on the Law of the Sea and Legal Advisory Committee, continued.

Close liaison and exchanges of ideas and information continued between counterparts in other countries: the Geographer of the U.S. State Department, Dr H. D. Hodgson; his deputy, T. V. McIntyre; the Danish Territorial Waters Officer, Commander Milan Thansborg; and the Canadian Hydrographic Service held discussions in 1973.

REPORT OF THE ASSISTANT DOMINION HYDROGRAPHER

Bathymetric Research

Bathymetry editions of 25 Natural Resource Maps were compiled during 1973. Five are of western arctic waters and the remainder of the east coast. Mapping of west coast waters was started.

Research projects initiated during the year were the issuing of a user preference questionnaire, an investigation into various line spacings, a study of sand waves in the St. Lawrence River, an investigation of the morphology of Flemish Cap, the production of an experimental mesomorphological map, and contributions to the Beaufort Sea Atlas.

Coordination of the Marine Science Paper series and geophysical editions of Natural Resource Maps continued.

General Bathymetric Charts of Oceans (GEBCO)

Four 1:1 million plotting sheets of Canadian responsibility on the east coast of Canada were recompiled and the Hudson Bay plotting sheets were updated. A special map of the Newfoundland Ridge at 1:1 million and a new 1:10 million general bathymetric map of the waters off eastern Canada were compiled.

The oceanic bathymetric data gathered during the *Hudson 70* expedition and the CSS *Parizeau* transpacific cruise were processed and distributed to 10 nations.

Three members of the staff participated in the *Hudson Overflow 73* cruise.

Nautical Geodesy

The unit participated in a joint field project at Amundsen Gulf to determine the ice effect on phase propagation at DECCA frequencies. The coordinating committee for offshore surveys initiated the project to meet a need for more accurate positioning methods in winter arctic surveys.

The Canadian Hydrographic Service planned and executed the project. Nautical Geodesy and the navigation group from the Bedford Institute of Oceanography prepared the plans and specifications in consultation with DECCA and ice specialists. Energy, Mines, and Resources' Polar Continental Shelf Project operated the DECCA Chains, and the Geodetic Survey of Canada carried out high-accuracy control work. Nautical Geodesy and the Central Region Navigation Group made phase lag observations during winter and summer conditions, to make comparisons for the detection of ice effect.

Technical Information Services

Chart distribution: 500,000 charts were distributed from Ottawa and Victoria in 1973; of this total 450,000 were navigation charts. This is a 14% increase over 1972 and is the fifth consecutive record year. Chart prices were increased in 1973 for the first time since 1956.

The Service exhibited: (1) recreational charts at the Toronto International Boat Show in February; (2) natural resource, bathymetric, and surficial geology maps at the Canadian Society of Exploration Geophysicists Conference in Calgary, Alta., in April; (3) navigation charts at the 23rd Permanent International Association of Navigation Congress in Ottawa in July; (4) navigation charts at an Ocean Expo at the University of Quebec, Rimouski, Que., in October.

The Hydrographic Data Center began the microfilming of the Service's field sheets and will place copies of the films in the Regions and at key points at Headquarters during 1974.

CHARTING DEVELOPMENT DIVISION

Introduction

During 1973 work continued in three main areas: (1) hardware development and systems implementation for production usage; (2) cartographic studies; (3) development of FORTRAN programs for computer aided compilation.

Hardware Development

Experimentation with and improvement of the drawing system were conducted when the system was not required for production. Two more control units were replaced: the linear interpolator for the Gerber plotter and the control unit for the Barr and Stroud light head. The highspeed data multiplexer was also replaced. All prototype interfaces and control units developed and built at the University of Saskatchewan have now been replaced. An operator's console, which provides the operator with visual feedback of the system, was also built and installed.

The Gradicon digitizer acquired in 1972 was in constant use during 1973, testing and optimizing the system and producing test data for the FORTRAN programers. Several improvements were made in the system to assist the operators and make the system more flexible.

A basic editing program was made operational on the digitizing system to allow changes and/or corrections to be made to the digitized data. A flexible conversion program was also written and implemented on this system so that the digitized data could be changed to the format required by the drawing system. This allows a drawing tape to be produced on the minicomputer without recourse to the larger computer, the CDC 6400.

A Tektronix 611 storage tube and a 9-track tape transport were added to the PDP-8/I minicomputer system. This allows digitized data to be quickly displayed and certain checks to be made. Also it allows magnetic tapes prepared for the drawing system to be examined prior to plotting. This is particularly useful for debugging new or modified computer programs.

Cartographic Studies

During 1973 most efforts were concentrated on the digitizing system. This entailed experimental and test digitizing of published charts and portions of field sheets. Draftsmen assisted by carrying out the digitizing and providing feedback for improvements.

More than 50,000 soundings, and several feet of shoreline and contours, have been digitized from field sheets, charts, and compilations and then drawn on film. Statistics are being gathered on the speed of digitizing and error rates. All significant errors appear to be human errors.

In summer a compilation of a simple chart inset was digitized and then drawn on film without smoothing or modification of any kind. The results appeared adequate to replace the scribe drafting phase for provisional or preliminary type charts. However, the time required to digitize the simple chart inset while scribing to leave a trace for checking and correcting errors was too long to effect any significant savings compared to manual drafting.

A study of drafting size-change of features was almost completed. This study endeavored to determine what, where, when, and why sounding digits, rocks awash, crosses, etc., changed sizes. Results of the study indicate that much of the symbol size-change is not absolutely required. Changing symbol size depends on the draftsman working on the chart. If, in the manual–visual compilation processes, the drafting standards and specifications and the purpose of the chart being constructed are kept in mind, the need to change size of symbols in drafting could be substantially reduced.

Cartographic Computer Programs

Drawing Programs: A large effort was devoted to the adaptation of computer programs to production versions for implementation into production. These are the drawing programs for the chart bases and navigation lattices. A few more programs and some enhancement to the mathematically generated programs could be attempted (such as border breaks, compartment charts, and lattice coverage limits and labels); however, these requirements have been given low priority. The following were also devoted to GEBCO requirements: (1) a listing program, for the standard GEBCO input card information, after converting the depth values to meters and correcting them from Mathews' tables, was printed out by GEBCO personnel; (2) a program was developed to draw the polar stereo sector plotting sheet at $1{:}2 \times 10^6$ covering an extent in longitude of 45°; (3) a program to produce a first draft of the GEBCO field sheet, that is, to draw a border and plot soundings along tracks, was developed.

Data Base: Systems analysis and design of data formats was conducted for the proposed rudimentary data bank. It has a flexible, straight forward

structure, in which information is organized into blocks, and each block is indexed through its covering rectangle of latitude–longitude. The basic retrieval process will be to provide a request rectangle of latitude–longitude, after which the data base system will find all stored rectangles which intersect the request rectangle, and copy out a work file containing all the data in these rectangles, trimmed to fit in the request rectangle. HAAPS data file format of January 1973, can be reformatted into the data bank through existing programs.

Sounding-Selection: A sounding-selection computer program in a simple basic form has been developed. It is expected there will be many modifications made, but the current version of the program appears to be satisfactory in open waters with few shoals. The shallowest depths in an area are always selected but the selections in confined areas are not adequate. Further experimentation and development will be conducted and hopefully its reliability and capability will be enhanced.

Contouring: Attempts are being made to develop a contouring program. Initial attempts were made to contour on a rectangular mesh, but this has been changed and efforts will be made to contour on a triangular mesh.

Production Implementation

Production requirements for conic chart bases are now being processed by Chart Production staff. A procedure manual has been provided and card punching of the specifications as well as the operations for automatic drawing are being carried out by compilers and draftsmen. Similar manuals for the Mercator and small craft projection chart bases, and DECCA and LORAN lattices will also be prepared after conversion of the computer program to a form usable by Chart Production.

Three Chart Production staff members were trained to operate the drawing system, others in groups of two or three observed all operations required for automatic drawing, and actual production jobs were processed. This should provide the necessary familiarity with the drawing process, and dispel any doubts about the operation.

During the previous fiscal year 155 sheets were drawn automatically. These include everything from small chart insets to large field sheet lattices. From January 1 to December 18, 1973, 167 sheets were drawn. (See Table 1.)

Most drawings were conducted at a constant slow speed of the plotter. The acceleration facility was not used because it took too much time to make the adjustments to bring the system up each time there was a production requirement, after the system was down for developmental work. Furthermore, because many jobs were started just before the end of the work day and the drawing taken off in the morning for developing, it did not matter if the drawing system was operated at the slowest speed.

Some preliminary figures indicate that for the regular chart projection bases the ratio of automatic

TABLE 1. Record of sheets drawn in 1973.

	Product requested	No. sheets	Total automatic drawing time (*h*)	Computer processing cost (DEMR-CDC-6400)
Atlantic Regional Office	DECCA Lambda range–range lattice	15	55	$ 310.00
Pacific Regional Office	DECCA Lambda hyperbolic lattice	8	89	320.00
	Hi-Fix hyperbolic lattice	8	35	109.00
GERCO,	Plotting sheets	14	21	9.00
Bathymetric research	NCR chart bases	1	1	9.00
Territorial Waters Office	Median line plots	1	1:50	3.50
Chart production	Chart bases	85	124:30	480.00
	Chart lattices	37	99:30	324.00
Total		169	426:50	1564.00

against manual is about 1:30 and the cost ratio is approximately 1:19. For the drawing of hyperbolic lattices, the ratio of time is about 1:19 and the cost ratio is roughly 1:14. This was based on an estimate by production staff on the length of time it would have taken to carry out the jobs by hand.

Future Plans

Hardware

This year additional improvements to both the drawing and digitizing systems will be made. It is intended to acquire a PDP-8/E with 8192 words of memory to replace the smaller PDP-8 computer with only 4096 words of memory. The drawing program will be completely revised for the new computer, and it is expected that all interaction with the computer will be via a teleprinter to make the drawing operation uncomplicated.

It is hoped that a compact numeric keyboard and display can be developed and incorporated with the digitizer cursor so that sounding digitization can be expedited and human errors reduced. Suitable space is needed for the digitizing system.

The display system, PDP-8/e, a Tektronix 611 storage display on loan to the University of Saskatchewan, will be returned in 1974, and a set of display programs developed at the University will be acquired and made operational. Study and experimentation on the capability and limitation of this display system will be carried out.

The development of programs for interactive use of the Tektronix storage display for digitizing and cartographic computer program development will continue.

Delivery of a basic PDP-11/40 minicomputer system is expected in 1974. This is a much more powerful minicomputer system than the PDP-8s presently being used and will allow efficient and useful programs to be written in FORTRAN rather than in the assembler language that is used with the PDP-8 computers.

If economic systems of automatic line following, character recognition, CRT drawing projector, etc., are developed and are applicable to automatic cartography to provide more expeditious, economic, and effective digitization processes and a better facility for drawing or symbol projection, then such systems will be considered for incorporation.

Cartographic Studies

Further experimentation and tests will be conducted with deep-etch scribes to determine the merits of such scriber for faster line following digitization. The magnitude and effect of inaccuracies due to the variation in width of the etched lines has to be determined, and better methods or materials for filling the etched lines for semiautomatic digitizing and verification will be investigated.

More digitizing will be carried out on larger field sheet sections to provide digital data for the development of the computer program for the compilation processes, the determination of statistics on time-cost and error rates, design and development of a compact numeric keyboard and display, design of a new digitizing cursor, and the improvement of the editing programs. Similarly, digitization is required for testing and improving the various digitizing, editing, and plotting programs.

Further investigation and evaluation of the application of displays for digitizing, drawing checks, compilation processes, comparison of data, etc., must also be done.

Similarly, participation in a study of the reliability of soundings should be conducted. This should entail the factors affecting the reliability and a system for applying reliability coding in the field.

Cartographic Computer Programs

Work on the development of the Data Base will continue as requirements become clearer from progress made in the development of compilation programs and programs concerned with the conversion of graphical data to digital form. Most efforts will be on the computer programs for the incorporation, storage, and retrieval processes. Data Base refers to the incorporation and storage processes, the data bank, and the retrieval processes.

Work will also continue on the sounding selection program, and within the next fiscal year a selection program, good enough to select soundings from some survey data for production use, may be in use.

Some effort will also be devoted to developing the depth contouring program, and the generalization program for shoreline.

Programs will also have to be developed to allow editing of the digitized data, as well as the compilation work-files and drafting work-files. Editing in this case refers to FORTRAN programs and not to the editing programs used on the PDP-8/I minicomputer.

In the near future, a cartographic drafting program will be developed. This program will produce a tape for the cartographic features, each feature to satisfy the drafting specifications concerning line weight, symbol size, dimensions of pecked lines, etc. This was started 2 years ago on the SDL 360/85, but has been left dormant because of more pressing matters. However, to complete the overall drawing system and for the effective and efficient conduct of the drawing from the digitization of the manual compilation, this program is required.

HYDROGRAPHIC PLANNING AND DEVELOPMENT

During 1973, studies continued on updating survey priorities, and two reports, Pacific Coast Survey Priorities and Central Region Survey Priorities, were produced. These reports were concerned primarily with traffic patterns, the quality of existing survey data, and economic developments that may have a future impact on shipping trends. By means of a matrix system, in which points are assigned to major factors influencing charting requirements, survey programs are established on a short-, medium-, and long-range basis. The reports are of a continuing nature and designed to ensure a realistic up-to-date national charting program.

The rapid increase in pleasure craft activity and the attendant demand for charts has placed an additional onus on the resources of the Canadian Hydrographic Service. To ensure commitments are met in a realistic manner, a study on recreational small craft and effects on the Canadian Hydrographic Service has been implemented. The findings should be available in 1974.

A preliminary study was made of potential pipeline crossings in the arctic archipelago and cost estimates were prepared for the complex surveys which could result.

Studies on the possible locations of deep draught terminals on the Atlantic seaboard and the eastern arctic islands were undertaken and detailed reports produced.

New aerial photography was obtained of areas on the coast of British Columbia, Lake Winnipeg, and the coast of Labrador. Most of this photography will be used for the production of photogrammetric plots which are in ever-increasing demand by field parties.

Liaison with the Canadian Coast Guard proved fruitful with the assignment of seven ships to northern hydrographic operations; several joint projects were undertaken. CCGS *Narwhal* and CCGS *Labrador* were assigned totally to hydrographic operations in James Bay and McDougall Sound, respectively, during the 1973 field season; CCGS *McLean* was engaged on survey operations in Chesterfield Inlet for a 4-week period and CCGS *John A. Macdonald*, CCGS *Louis St. Laurent*, CCGS *Camsell*, and CCGS *d'Iverville* undertook reconnaissance surveys to expand coverage in sparsely surveyed areas in the arctic archipelago and central arctic during September.

Numerous requests for surveys were received during the year and after evaluation were forwarded, when appropriate, to the regional offices for field survey action.

The following publications were completed by the Sailing Directions Unit and made available to the public: Sailing Directions, British Columbia Coast (South Portion) Vol. 1, Eighth Edition; British Columbia Small Craft Guide Vol. 1, First Edition; Trent-Severn Waterway Small Craft Guide, First Edition; and Supplement No. 6 to the Second Edition of the Labrador and Hudson Bay Pilot.

The following new editions of Sailing Directions are in preparation: Gulf and River St. Lawrence; Newfoundland, Fourth Edition; Labrador and Hudson Bay, Third Edition; Mackenzie River, Third Edition; Supplement No. 5 to the Great Lakes Pilot, Vol. 1; and the British Columbia Coast (North Portion), Vol. 2, Sixth Edition.

Translation into French of the Sailing Directions of the Gulf and River St. Lawrence and the Sailing Directions, Nova Scotia (SE Coast) and Bay of Fundy was completed and work continued on the translation of the Labrador and Hudson Bay Pilot.

Extensive use is being made of the Alphatext system in the preparation of Sailing Directions. By means of this system it is planned to issue updated new publications as required, eliminating the necessity for supplements.

Existing standing orders on field methods and procedures were reviewed on a continuing basis and inspection and evaluation of numerous field manuscripts were made.

Research on the characteristics of VLOCs was carried out and 12 volumes of background data were compiled.

Shoal areas in the vicinity of traffic separation schemes were investigated and where further clarification was considered necessary, the regional offices were informed so appropriate action could be taken in the future; a tabulated list of doubtful data was also prepared and forwarded to the regional offices for investigation should survey vessels be in the vicinity.

Field training for new recruits was conducted in the Caribbean during the winter months of 1973. Surveys were undertaken at Canouan, a small island in the Grenadines, at Rousseau Roads in Dominica, and at St. Vincent Harbour. On the latter project, a deepwater wharf was surveyed at the request of local authorities. The data obtained from these surveys are being processed and will be forwarded to the British Admiralty for chart revisory action.

During the initial stages of the training cruise, trials were conducted successfully with underwater transponders and on the return voyage to Dartmouth an oceanographic program was undertaken.

Prior to the training period in the Caribbean, the 13 trainees attended the basic hydrographic course at Algonquin College of Applied Arts and Technology, Ottawa.

Two hydrographic surveyors from the Guyanese Hydrographic Service were seconded to the Canadian Hydrographic Service for training, and attended, with Canadian trainees, the course at Algonquin College during the latter part of 1973. The 1974 field training exercise is being carried out in the approaches to Georgetown, capital of Guyana, and combined with production in a multidisciplinary survey by CSS *Baffin*.

The survey project is being undertaken as part of an overseas aid program and will not only provide modern survey data but serve to acquaint Canadian and Guyanese trainee surveyors with modern survey techniques.

The Canadian Hydrographic Service is also assisting the U.S. Corps of Engineers with the establishment of a training program in 1974. Canadian participation in this program arose from a series of short seminars given by CHS training staff at the Second Annual Hydrographic Conference of the U.S. Army of Corps of Engineers in Mobile, Ala. Canadian instructors will be involved in the initial U.S. course.

CHART PRODUCTION DIVISION

Introduction

Primary function of the division is to produce new charts, revise existing charts, and maintain up-to-date chart stocks for two distribution centers in Ottawa and Victoria, as well as the Department of National Defense chart depots in Halifax and Esquimault. Due to unprecedented demands for charts, the major priority was to minimize out-of-print situations. Unfortunately, the printing service was unable to keep pace with demands. Only minor inconvenience to the mariner was experienced in this regard although the change in priority caused a reduction in production of other publications.

During 1973, 376 individual charts, maps, indexes, etc., were printed for this division by the Map Reproduction Division of the Department of Energy, Mines, and Resources, representing a 20% increase in total projects over 1972.

New stocks of charts printed in 1973 included 108 new editions, 147 corrected reprints, 29 reprints, and 11 miscellaneous projects. As of December 31, 1973, 63 metric charts were published (21 printed in 1973). Three new lattice charts were printed for an accumulated total of 87 and 4 bilingual standard chart editions were produced for an accumulated total of 26. (See Table 2.)

As of December 31, 1973, 102 charts were at press. Indications are that an additional 200 charts will have to be printed before June 1974.

Several tours, both formal and informal, were conducted. Most noteworthy was the tour arranged for delegates to the Permanent International Association of Navigational Congresses, in July 1973.

TABLE 2. Chart catalog to December 31, 1973, and breakdown of 1973 production activities.

New charts	Total to Dec. 31, 1972	Printed 1973	Cancelled 1973	Total to Dec. 31, 1973
Standard navigation	833	20	20	833
Small craft	138	3		141
Fisheries	12	1		13
Bathymetry	11	3		14
Geology	7	1		8
Natural resources:				
Base	31	32		63
Bathymetry	31	17		48
Gravity	14	3		17
Magnetic	5			5
Territorial sea and fishing zones	22	4		26
Miscellaneous	67			67
Total	1171	84	20	1235

Chart Compilation Section

Compilation of new charts, updating of published charts by Notices to Mariners amendments, and revisions for new editions or corrected reprints continued at an accelerated pace. The increase in distribution of charts created an above-normal work load on hand amendments and revisions.

New functions undertaken during the year included the provision, on request, of Notices to Mariners information to purchasers of small-craft charts (1500 copies of Notices to Mariners listings were mailed to chart users). In addition, for the first time in several years, compilation staff participated in survey operations. Three compilers took part in the revisory survey program for the St. Lawrence, Trent–Severn, Rideau, and Ottawa rivers and 12½ weeks were spent in the field. The compilers reported a useful exercise that increased their knowledge of hydrography.

The Charts and Publications Regulations have placed an additional requirement on the production and maintenance of up-to-date chart catalogues. To facilitate this production, the text information on these publications is processed by an automated system, Alphatext.

Establishment of marine traffic routing systems in Canadian waters continued during the year and the traffic separation scheme for Halifax Harbour was compiled and published on Charts 4312, 4385, and 4320.

Compilation work on new charts included the continuation of the recharting of the arctic in metric format, additional new charts for the Mackenzie River, and the compilation of two new charts in the International Chart series. The compilation of a prototype of a new chart in a series schemed for the St. Lawrence River from Montreal to Quebec was completed and two others in the series are being compiled.

Work continued on the compilation of NSC charts and a program of updating published NSC charts was undertaken. New fisheries charts have been compiled for the northern area of the Grand Banks, and these extend coverage east to Flemish Cap. New charts for James Bay were compiled and published in 1973 to provide the shipping industry with up-to-date survey data. Two new charts of the Sir Charles Hamilton Sound area, Nfld., were completed and issued for ships navigating that area during winter months when ice conditions create a hazard to navigation. New chart compilation continued to provide assistance to the production of the Natural Resource Series by compiling nine mosaics of field data for the NRS bases. Compilation of the bathymetry for four Joint Operational Maps (DND) were completed.

In summary, new chart compilation totaled 18 new charts, 28 new editions of charts, preparation of several chart schemes and chart formats; in addition to miscellaneous work.

Compilation of data for the publication of new editions included 56 charts in standard format, 7 metric new editions, and 2 bilingual new editions, for a total of 65. Also, 13 Information Bulletins were revised, and 4 indexes for Sailing Directions publications and 51 patches were processed. Considerable assistance was provided to the Regions in support of survey activities. This included the preparation of revisory survey data and filling requests for aerial photos, topographic maps, and topographic plots. Some 150 projects in this category were processed.

The Notices to Mariners and Aids to Navigation Section processed about 300 jobs related to the provision of aids to data to production units, the processing of information for corrected reprints, and NRC charts. Notices to Mariners for the year totaled 1160 paragraphs.

The increase in chart distribution during the year dictated higher productivity in hand amendments, and 2,634,850 were applied to published charts.

Compilation staff participated in papers at the Hydrographic Service Conference in Victoria and in lectures and tours to students in the hydrography course. Attendance and participation at the meetings of the Dominion Marine Association, Northern Transportation Company, Edmonton, and MCAPP were undertaken. Chart compilation staff played a leading role in the Interagency Routing Work Group of the Interdepartmental Hydrographic Steering Committee, and Work Group A of the CHS–LSC Charting Advisers. The latter work group has the task of making a comparative study of U.S. Lake Survey Center charts and Canadian Hydrographic Service charts to achieve compatibility where possible. The report will likely form the basis of a Great Lakes International Chart Commission.

Staff changes in promotions during the year included the appointment by competition of three supervisors to fill vacancies, and one new compiler recruited to fill an existing vacancy.

Chart Production and Quality Control Unit

Quality Control

The Production and Quality Control Unit reviewed and approved production and printing of 215 reprints and corrected reprints, to replenish published chart stocks. They reviewed for approval 123 new editions, 21 new charts, 16 Natural Resource Maps, 68 sets of specifications, formats, and titles for the production of new charts, and 36 color proofs of completed

charts, comprising 18 Natural Resources Maps, 6 nautical charts, 3 small craft charts, 4 fisheries charts, 2 bathymetic charts, and 3 special charts.

Translation and Bilingual Programs

Four bilingual charts were published in 1973. The bilingual program for nautical charts slowed down during the year because of changing priorities. However, a new bilingual program was started for the Natural Resources Series of maps. All translated technical terms, notes, and texts for charts are being accumulated in a reference manual for the production of future bilingual charts.

Personnel

On March 1, 1973, J. P. Racette, Quality Control Officer, was promoted to the Chart Compilation Unit. This position is now being filled in an acting capacity by P. MacMillan.

Miss T. A. Finnerty, production statistics clerk, was promoted to a new job with the Ministry of Transport in July, 1973. Only the primary functions of this position are being carried out at this time.

Drafting and Reprographics Section

In 1973 the Chart Drafting Section was diversified. Cartographic services were expanded beyond the normal production of navigation charts to include projects for many areas of the department. One was the project for the Minister, consisting of a series of six folders and four sets of projection slides depicting offshore fisheries areas. This was followed by a series of charts showing the fishery areas on the east coast of Canada in relation to proposed routing schemes for commercial shipping.

First Editions, New Editions, Reprints

Each year more effort must be diverted to the chart maintenance program as published chart stock increases. This is shown by the decrease in the number of new charts produced in 1973; however, it balances with the increase in maintenance and the special projects program. Forty-seven first editions were completed including standard navigation charts, smallcraft charts, a Pilot Index bathymetric charts, charts for marine sciences papers, and bathymetry maps of the Natural Resource series.

The new edition output was high, with 109 editions completed including the Mackenzie River Series, Information Bulletins, and reconstruction of the Welland Canal Chart.

An all-time high of 152 corrected reprints were completed with straight reprints accounting for an additional 27.

Chart patches for the year numbered approximately 60, mostly issued by N to M.

Special Projects

Miscellaneous and special projects increased with requests from Territorial Waters, Oceanography, Research and Development, Tides and Water Levels, Sailing Directions, Fisheries and Marine, Department of National Defense, Ministry of Transport, etc. The requirements varied from graphic illustrations to preparing type overlays for photographs, drawings for the preparation of 35-mm slides, display material for conferences, silk-screen printings for signs, covers for maps and papers. Artwork for special functions and presentations was undertaken.

Automated Production Drawing

During 1973, 166 projects were processed on the CHS automated drawing system. The drawing system consists of a computer-controlled Gerber Model 32 plotting table mounted with a Barr and Stroud light head, and a Potter Tape Transport. In the drawing process a sheet of film is placed on the surface of the plotting table. The drawing tape which contains the graphical data to be drawn is mounted on the tape transport. The computer reads the tape, interprets it, and controls the operation of the light head and the plotter as the drawing progresses. Drawing is accomplished by exposing the film to a controlled beam of light projected from the light head as it moves over the film. The system produces graphics with well-defined, constant density lines with minimal linewidth variation, drawn to a high degree of accuracy.

A breakdown of the projects processed on the system during 1973 includes: 87 chart bases (various projections with skeleton or full graduated borders), 37 lattices (DECCA and LORAN), 14 GEBCO plotting sheets, 27 latticed field sheets, and 1 Territorial Waters plotting sheet.

Total automatic processing time, which includes programming, checking, and drawing system preparation time, was 87.87 man days. Total estimated manual production time, had the work been undertaken by Chart Compilation and Chart Drafting, would have been 953.74 man days. The total manual production time quoted is only an average time estimate.

Of the 166 production jobs processed on the drawing system, a field requirement of 27 latticed plotting sheets required 15.96 man days processing

time. This figure represents an estimated 272.48 man days work, had the sheets been prepared manually.

During 1973, four draftsmen were assigned to the Charting Development Section for varying periods of time to participate in the development and study of line and point digitizing programs. This involved 66.53 man days effort.

In September, the Charting Development Section supplied Chart Production with a User's Guide for the Skeleton Border Program. The guide provides the necessary information for compilers and draftsmen to keypunch chart specifications for skeleton border projections onto IBM cards. User's Guides for smallcraft bases, lattices, and projections with full graduated borders, are being prepared for production implementation.

A program was initiated in which Chart Production staff members, two or three at a time, had the opportunity to acquire a better knowledge of automated drawing as it pertains to production requirements. Compilers and draftsmen prepare keypunch cards with the specifications for a particular chart base or lattice utilizing the "User's Guides." The cards are processed at the Computer Science Centre and a drawing tape generated. The job is then processed on the drawing system. This is not a crash training program, but rather a gradual familiarization process, in conjunction with production jobs as they are scheduled.

As of April 1, 1973, the responsibility for production drawing on the ADS was delegated to the Chart Production Division. R. W. Cashen, who had been assigned to the Charting Development Section, returned to Chart Production and is supervising the automated processing of production work on the drawing system and coordinating Chart Production staff participation in production processing operations.

Nomenclature Unit

During 1973 names on nearly 100 charts, both new and revised editions, were compiled and checked. This involved continual liaison with the staff of the Canadian Committee on Geographical Names (CPCGN), preparation of name submissions, and further liaison with Provincial and Northwest Territories representatives, regional hydrographic offices, and other units preparing chart and sailing directions, compilations, or revisions. The transition to bilingual charts involved translation into French of various generic terms related to the nomenclature shown on nautical charts and nautical publications.

Pacific Region

INTRODUCTION

A major highlight of the year was the publication of the first British Columbia Small Craft Chart 3310 and the complementary Small Craft Guide, Vol. 1. Both publications were well received with over 7000 copies of Chart 3310 sold in less than 6 months.

Another first was the compilation, drafting, and printing of a new tidal current atlas of Vancouver, produced completely by the regional office. A significant factor was that the four-color printing was done locally on contract, with the quality comparing favorably with that produced by headquarters.

FIELD HYDROGRAPHY SECTION

This section under Regional Field Superintendent R. Wills, is responsible for all hydrographic field operations in the Region, including Sailing Directions and a Hydrographic Development Group. Activities are described in terms of the major and intermediate field parties to which the survey projects are directly assigned.

CSS *Parizeau* carried out two main projects in 1973. The first was a Natural Resources Charting Survey (hydrographer in charge, R. W. Sandilands) conducted April 25–June 8, in conjuction with the Department of Energy, Mines, and Resources to collect gravity, magnetic, and seismic data as well as bathymetric information. The area surveyed was Queen Charlotte Sound to beyond the continental slope.

This was the first complete multidisciplinary survey of this nature in the Pacific Region. It was both productive and beneficial in regard to the training of personnel and experience gained. All agencies reported a high percentage of usable data. In addition to 5472 nm of bathymetric soundings, 5352 nm of magnetic, 5045 nm of gravity, and 1745 nm of seismic data were recorded.

Of the 43½ operational days, 3¾ were lost to weather and weekends, 3¼ to equipment failure, and 9½ to logistics and other causes (air-sea rescue, hospital run, etc.).

The second project, July 4–September 28, was the Western Arctic Survey with E. B. Clarke hydrographer in charge. This was also a Natural Resources Charting Survey similar to that conducted in Queen Charlotte Sound, but with greater emphasis on bathymetry and hydrography for navigational purposes. The main area of operations was the western half of Amundsen Gulf between Banks Island and Cape Parry. A large amount of data was also collected on passage to and from the arctic, and a small reconnaissance survey was done of the approaches and entrance to Summers Harbour, Booth Island.

Heavy concentrations of ice were experienced off Cape Barrow during passage to the survey area, which caused some ship hull damage. Throughout the cruise, particularly in August, ice was a major problem and continually blocked efforts to accomplish any work on the most western field sheets, but weather conditions in general were exceptionally good.

The magnetometer and the gravimeter operated successfully throughout the season with only occasional minor breakdowns. However, there were two major equipment failures, the PDP 8/e computer and the satellite navigation receiver.

A total of 15,154 nm of soundings were obtained and preliminary reports indicate that good magnetic gravity and seismic data were collected – 9738 nm magnetic (5347 track), 9807 nm gravity (5347 track), and 226 nm seismic. Bottom samples and sound velocity readings were taken throughout the main survey area and cores were taken at 11 stations. Fish trawls were run for 1-hour periods on selected lines, usually in conjunction with bottom sampling operations.

CSS *William J. Stewart* under the direction of C. G. McIntosh was engaged in conventional hydrographic surveys on the British Columbia coast April 16–October 12. Main areas of operation were Howe Sound, Strait of Georgia, Malaspina Strait (including Powell River and Westview), and Arthur Passage in the approaches to the Skeena River. A total of 3673 nm of launch soundings were recorded.

A complete resurvey of Howe Sound was conducted with special emphasis on Shoal Channel and the approaches to and the port of Squamish. Of particular interest on this survey was the successful use of infrared and color photographs to define the low water line. The Howe Sound project was hampered by log booming grounds in the area. In many instances they extended from shore to 40 or 50 fathoms of water and caused difficulty with the continuity of inshore soundings. To overcome this problem a hand transportable echo sounder was devised, using an Edo digital sounder and light

transducer from one of the launches, with a Honda 12 v battery. Though time-consuming, this method worked well and enabled spot soundings to be obtained to 30 fathoms.

The Strait of Georgia project completed the modern survey of the Strait with the exception of the central part of Malaspina Strait. A large-scale survey of Powell River and Westview was completed. Motorola and Trisponder positioning systems were used on the surveys and worked well, with practically no down time.

The Arthur Passage project, carried out near the end of the season, was hampered by weather ranging from bad to atrocious, when visibility was greatly reduced by heavy rain and fog. In spite of this only 1 of 28 days was completely wasted due to weather.

Haro Strait Shore

J. B. Larkin, two assistant hydrographers, a coxswain, and a seaman made up the work party. Main items of equipment were the 20-ft launch *Tern*, a 17-ft Boston whaler, a small office trailer, and a Motorola RPS.

The projects were (1) completion of shoal examinations and shoreline checking in Esquimalt Harbour and approaches, started in 1972, and (2) completion of the Haro Strait survey, started in 1970.

The Esquimalt Harbour project began April 9 and continued periodically throughout the season for 67 operational days. In the course of this project 113 nm of soundings were recorded and 43 shoals examined. Included was a large scale survey, 1:4,000, of Constance Cove.

The Haro Strait project started May 28 and continued for 118 operational days. It produced 570 nm of soundings in a 42-sq nm area. The projects completed three field sheets and three wharf plans.

A shoreline and low water plot, including shallow water bathymetry, prepared by Airphoto Analysis Associates, was used on the Haro Strait survey. Although not without discrepancies and omissions, this plot greatly assisted the hydrographers in the field. It forms a part of the continuing research in the Aerial Hydrography Project.

In Plumper Bay, Esquimalt Harbour, a log debris removal project was evaluated. A sweep was made with side scan sonar and the records were invaluable, as it was difficult to make an intelligent judgment on the basis of a normal echogram trace alone.

Revisory Surveys

A. D. O'Connor was in charge of the surveys which employed CSS *Richardson* and CSL *Revisor* for 202 days.

The first project was a revisory survey of Shuswap Lake, about 200 miles northeast of Vancouver. The launch *Crane* was used and the project completed in 7 operational days, 2 of which were actual field work. As a result of this work Chart 3501 was revised.

The second project with CSS *Richardson* lasted 156 operational days, 98.5 of which were occupied in actual field work. The first task of this project was to assist *Parizeau* in the calibration of the Hi-Fix system for the Queen Charlotte Sound operations; the remaining time was devoted to the northern and southern areas of the British Columbia coast, including the Queen Charlotte Islands.

This was the first year a revisory survey party had been assigned to northern areas; in the past, revisions on the northern B.C. coast were carried out on an opportunity basis by parties engaged in normal hydrographic surveys. Consequently, a large number of changes were noted. Visits were made by *Richardson* to the location of each reported change and revisions were made of the charts traversed en route; aircraft were chartered to fly over charted areas where little change was expected.

Another project involved the large-scale survey of a portion of Patricia Bay, the future home of the Institute of Ocean Sciences. Revisions were continued in the Strait of Georgia and the survey proceeded to Pitt River, northeast of New Westminster. The work there involved the recovery and photo-identification of the Department of Public Works' control, the coast-lining of the river, and collection of supplemental information. This involved 22 days field work.

Other miscellaneous projects were undertaken, including a large-scale survey at Fishermans Cove.

As a result of the season's work the 3800 series of charts covering the Queen Charlotte Islands was revised as well as charts 3711, 3722, 3729, 3730, 3733, 3736, 3739, 3740, 3743, 3745, 3772, 3781, 3790, 3993, and 3794.

Several aircraft were used successfully. The Beaver aircraft was particularly valuable as its construction enabled a K-20 camera to be used through the floor of the cabin for vertical photography of low water shorelines. A Cessna 185 in the Bella Coola area enabled chart checks to be carried out in 4 hours that would have taken 3 days in *Richardson*, and a Cessna 180 aircraft was used to cover a territory in the Queen Charlotte Islands in 8 hours that would have taken *Richardson* 10 days (weather permitting).

Mackenzie River Survey

This survey was conducted by G. E. Richardson and used the the Northern Transportation Co. chartered

vessel *Radium Express* as a base of operations. Of the 99.5 days in the field, 12 were lost to weather, 1 to equipment failure, and 3½ to weekends and holidays.

About 4½ days were consumed in locating a sunken DPW dredge at Norman Wells, using side scan sonar. Another day was spent using the same equipment to locate a sunken tank at Fort Norman.

After these projects, sounding surveys of charts 6417, 6418, 6423, 6425, 6426, and 6438 were completed and revisory surveys of East Channel, Kugmallit Bay, and Tuktoyaktuk carried out. Reconnaissance surveys were made in Husky, Phillips, and Enoch channels.

Sounding surveys are now continuous from Old Fort Point (Mile 480) to Point Separation (Mile 915) and reconnaissance soundings have been done in most of the delta channels.

A Mini-Ranger positioning system was used and it gave excellent service and suffered no down time.

HYDROGRAPHIC DEVELOPMENT GROUP

Three members of the Hydrographic staff on rotation and one university student made up the group, headed by N. M. Anderson.

The group evaluated two range–range positioning systems, Mini-Ranger and Trisponder.

The Mini-Ranger system's stability, precision, and repeatability were observed from baselines ashore at various ranges from 2 to 21.5 km, and to 12 km afloat.

A report titled An Evaluation of the Mini-Ranger Positioning System has been published.

The Trisponder positioning system was reevaluated after the manufacturer developed a new transponder. A launch failure limited the sea trials but all land-based tests were completed and the results published in An Evaluation of the Trisponder 202A with Model 210 Transponders.

Because systematic errors (delays between "receive" and "transmit" in the transponders) seem to be inherent in these positioning systems, seven base lines ranging from 2 to 21.5 km were established and will be used for future evaluation of short-range systems. For evaluation of these systems at their maximum ranges additional test ranges will be needed.

Several computer programs were written by the university student, M. Gillett, for the compilation and analysis of survey statistics. These include: daily plots of weather data, useful for planning aerial photography; final field report statistics, a program to compare man/days versus each project; chart priorities, in conjunction with the report on survey priorities this program can be used to alter priorities through change of different factor; and critical path, a computerized plot of the critical path of the Canada Centre for Remote Sensing (CCRS) Aerial Hydrography Project to be carried out in 1974.

Work on the Aerial Hydrography Project is proceeding and CCRS agreed to develop an airborne hydrographic system (AHS). An engineer and a technician from MSD Pacific have been assigned to CCRS, Ottawa, for the duration of the project. Functional parts of the AHS include the initial navigation system (INS), the airborne terrain profiler (ATP), the camera (RC-10), and the airborne data acquisition system (ADAS). The central part of the processing facility is the analytical plotter (APC).

SAILING DIRECTIONS

A revision of the British Columbia Sailing Directions, Vol. 1, was completed. This involved the incorporation of 586 alterations and additions, varying from single words to several pages (new regulations). During this revision the coordinates for all place names in the index were included to provide a gazetteer function. T. L. Jones supervised.

The British Columbia Sailing Directions, Vol. 2, was rewritten to conform with the new format for all Sailing Directions. This will be published in 1974.

A revision of the Small Craft Guide, Vol. 1, was also completed with 231 alterations and additions. This will also be published in 1974.

In August, J. Chivas undertook a revisory survey of the area covered by the Kootenay Lake and River Sailing Directions and collected information for the revision of this publication.

The group also undertook the compilation of a first draft of Instructions for the Revisers of Canadian Sailing Directions which will eventually become the official manual for the guidance of Sailing Directions personnel.

CHART CONSTRUCTION SECTION

This section, under Regional Chart Superintendent F. R. Smithers, consists of the Chart Compilation Unit, Chart Revision Unit, Chart Correction Unit, and Chart Distribution Unit.

The Compilation Unit under R. D. Bell completed the compilation of the first editions of: Chart 3701, Prince Rupert Harbour; Chart 3804, Masset Harbour; Chart 3980, Plans in Chatham Sound; Chart 3532, Baynes Sound and Approaches; Chart 3989, Brown Passage; and Chart 3991, Hudson Bay Passage.

This unit undertook the construction of public displays, preparation of graphic art work, illustrations for various publications, and fulfilled the photographic requirements of the Region; it also prepared most regional publications for the printer.

Among the displays and exhibits prepared and set up was the nautical chart display at the Vancouver International Boat and Sport Show, held during a 2-week period in February. The object of the display was to promote the sale of the new small boat chart 3310; 700 sets were sold at the show.

Shopping mall displays were also used to demonstrate the work carried out by the hydrographic and oceanographic elements of the Region. These were shown at Lougheed for 3 weeks; Richmond, 2 weeks; Brenwood, 6 weeks; Nanaimo, 2 weeks; South Park Royal, 4 weeks; Pacific Centre, 3 weeks; and Victoria Jaycee Fair, 1 week.

The Strait of Georgia model, one of the main attractions at these displays, was placed in the Student Union Building at the University of British Columbia until early 1974, when the shopping mall displays began again.

The Chart Revision Unit, headed by K. R. Holman, completed the compilation of the changes to 12 new editions of nautical charts from new hydrographic information. Major corrections were drawn and published on 40 chart correction patches. The unit prepared 51 Notices to Mariners for promulgation and processed 72 MAREP reports received from various Power Boat Squadrons.

The Chart Correction Unit, under Mrs E. M. Coulter, hand corrected 267,500 charts, which required 2,118,400 individual corrections, prior to distribution.

The Chart Distribution Unit, under C. J. Nast, processed and distributed 165,000 nautical charts and 40,000 related publications to the general public and over 180 authorized dealers. It inspected the facilities of 84 dealers and cancelled 11 dealerships. Twenty-two new dealerships were authorized.

TIDAL AND CURRENT SECTION

A major current survey from February to June employed 42 current meters to monitor the flow through Johnstone and Juan de Fuca straits simultaneously. One purpose of the survey was to define for the first time the net circulation around Vancouver Island.

A new tidal station was brought into service at Langara Point on the northwest corner of Queen Charlotte Islands. This station is being joined to the Tsunami Warning System for the Pacific, and will provide warning information more than 1 hour earlier in the event of a tsunami from an Alaskan earthquake.

Improved tidal predictions along the lower Fraser River have been produced by the application of the previously developed numerical model. Study of the salinity wedge in the Fraser delta continued, and field measurements made with a Salinity–Density–Temperature (SDT) instrument. Work was started on a two-dimensional numerical model of Burrard Inlet, to improve interpretation of the circulation in Vancouver Harbour.

In the arctic, five tide gauge stations were installed around the southern perimeter of Amundsen Gulf to expand and update existing tidal information and support the hydrographic charting program of CSS *Parizeau*. Water level recorders were operated on the Mackenzie River throughout the ice-free period to establish vertical control from Fort Good Hope to the delta in support of the charting program in that area.

For the first phase of the 18-month Beaufort Sea Project, tide gauges were installed in September at Herschel Island and Cape Bathurst to record throughout the winter. In addition a helicopter party in October moored in situ tide gauges and current meters through the ice pack offshore; these instruments will be recovered by ship in July.

During the year, the section compiled and published: Atlas of Tidal Current Charts, Vancouver Harbour (CHS Tidal Publication No. 30); Manuscript Report Series, Vol. XI, data record of current observations; Strait of Georgia, Porlier Pass to Sand Heads, 1969–1972; Manuscript Report Series, Vol. XII, data record of current observations, Strait of Georgia, Samuel Island to Point Roberts 1969–1972; Manuscript Report Series, Vol. XIII, data record of current observations, Strait of Georgia, Northwest Bay to McNaughton Point, 1968–1969; and a numerical model of Victoria Harbour to predict tidal response to proposed hydraulic structures.

SURVEY ELECTRONICS SECTION

Primary task of this section is to provide electronic maintenance, installation, and repair services for Hydrographic Service and the Ship Section. Another responsibility is to provide engineering and technical support to various groups within the Region (e.g., Ocean Chemistery, Tides and Currents, Coastal Zone Oceanography). R. W. Taylor was in charge during J. V. Watt's absence.

Maintenance, repair, and calibration services were provided in the field and the electronics laboratory for a variety of electronics equipment and systems in use aboard the ships and launches of the Pacific Region. Equipment serviced included sonar and echo sounder systems, precise positioning systems, data acquisition systems, tellurometers, ships' radar and navigational equipment, HF and VHF communications equipment, computers, and computer peripherals.

To the two Motorola Range Positioning Systems (RPS) and one Motorola Mini-Ranger System (MRS)

in service another MRS was added. To avoid returning the MRS equipment to Motorola for overhaul, equipment was acquired to do this work in the electronics lab as is done with RPS equipment.

A significant modification was made to the RPS in *Parizeau* which involved tying the multiplexer into the DECCA 629 Radar wave guide to enable that transmitter to assume the master function. Using this configuration *Parizeau* was able to work at the specified range of the RPS.

In communications, the conversion from AM to SSB in the Region's ships was begun, starting with the installation of a 12 Channel transceiver in *Richardson*. UHF transceivers were installed for the first time in *Richardson*, *Revisor*, and *Gulf of Georgia No. 192*, the support barge for *Pisces IV*.

During the year T. A. Curran joined the Section as an electronics engineer specializing in design and development. This activity, at the request of Ocean Chemistry, performed range scaling on the PCO2 analyzer to make the output compatible with the Honeywell recorder input. Two temperature monitors, supplied by Inter-Ocean Systems, were calibrated and interfaced to Heathkit chart recorders. Extensive modifications to an LDC mercury monitor were carried out to increase sensitivity and reduce noise.

Coastal Zone Oceanography also required a major portion of the available development time, primarily due to the design and maintenance of an electronic bathythermograph (EBT) used extensively in Babine Lake.

A development program was established to constantly improve the EBT which necessitated both lab and field work. A pulse-shaping unit was developed for Computing Services to improve the reading of poorly recorded Anderson data tapes. A small printed circuit facility was also established to enable prototype circuits to be produced rapidly.

Since April, Head of the Section, Mr Watt, has been in Ottawa on a special project at CCRS involving an Inertial Navigation System and its possible future application to Hydrography. His assistant is D. Gregson, a junior electronics technician.

The Library

Administered by Sharon Thomson, the library has a rapidly growing collection of reference materials needed by Regional research officers. There are approximately 3500 items catalogued plus 50 journal subscriptions. Of the former, 1894 were catalogued in 1973.

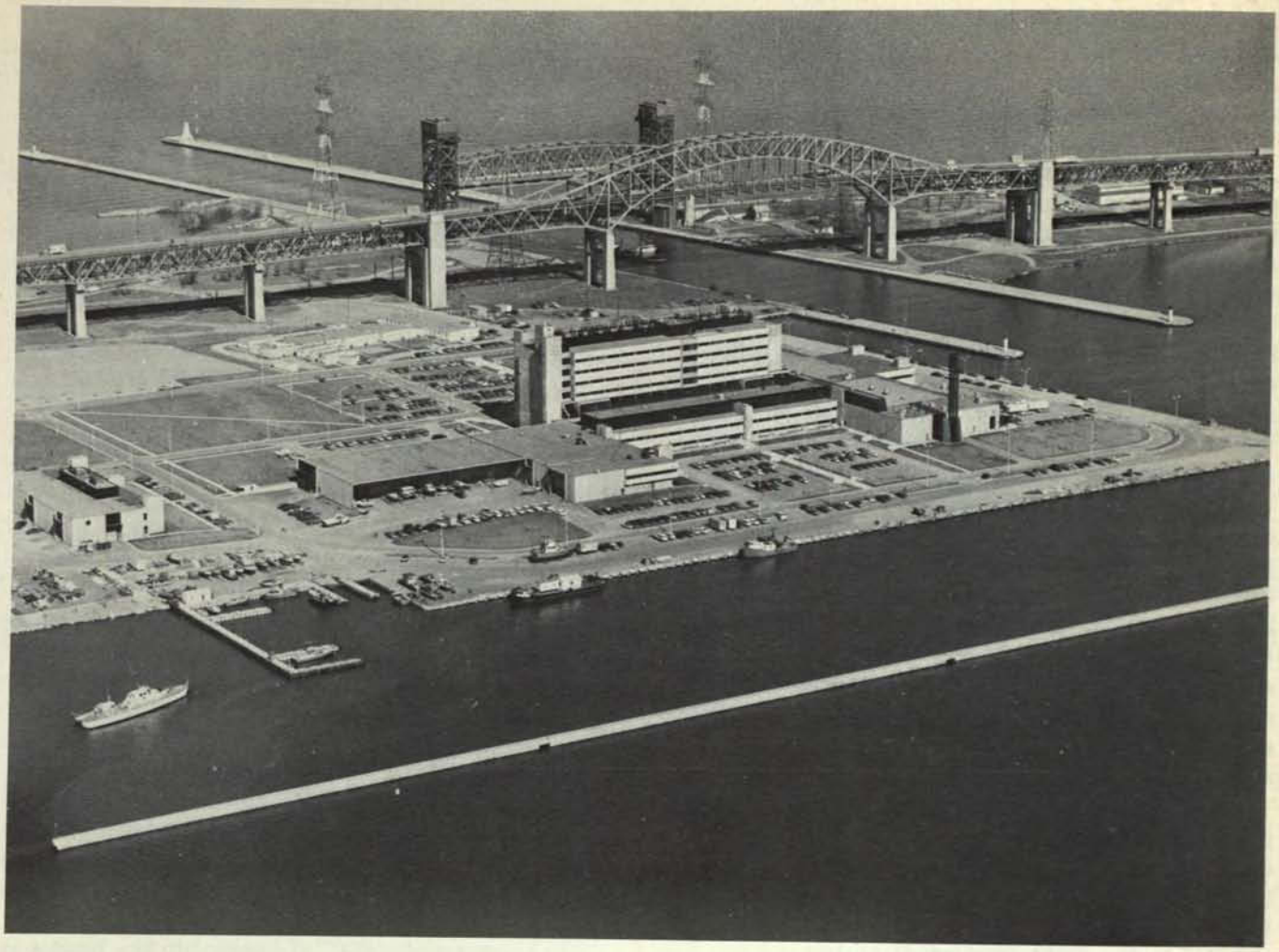


FIG. 1. Canada Centre for Inland Waters, Burlington, Ont.

Central Region

INTRODUCTION

Central Region had another successful year in 1973, with 46 field hydrographers actively involved in supporting programs that covered many areas of geographic responsibility. The programs were carried out under the direction of A. J. Kerr, who was appointed to the position of Regional Hydrographer early in the year.

Eight major surveys were started, as well as a number of smaller surveys. In the northern arctic two programs were undertaken — a through-the-ice bathymetric survey of Norwegian Bay and a DECCA signal velocity study in Amundsen Gulf.

A navigation corridor in James Bay was completed between La Grande Riviere and Hudson Bay. A reconnaissance survey was made of Chesterfield Inlet, on the northwest side of Hudson Bay, to prepare for a major undertaking in 1974.

In the western areas of the region, parties operated on Lake of the Woods and Lake Winnipeg. At Lake of the Woods the survey concluded a 6-year program to chart the waterways. The Lake Winnipeg survey was the first year of a planned 5-year program to survey the northern half of the lake and to conduct detailed surveys of all the lake's harbors.

Numerous activities were started in the Great Lakes. On Lake Erie, hydrographers supported the IWD limnogeology program in addition to collecting standard hydrographic data. A complete resurvey of Lake St. Clair was undertaken. Charting of this area will be a cooperative program with the U.S. Lake Survey Center. The bathymetric program on Lake Ontario, part of the International Field Year for the Great Lakes, was completed early in 1973. On Lake Superior, a horizontal control operation was started at Thunder Bay to prepare for a full hydrographic survey in 1974.

In 1973, the Region awarded a second contract for a complete hydrographic survey. The survey on Georgian Bay has shown that private industry can successfully undertake projects of this order.

Survey of the lower St. Lawrence River continued for the fourth season, and another 2 years' work is anticipated to reach Quebec City.

The systematic revisory survey, to maintain up-to-date charts, was continued. Navigational Ranges survey accurately determined all ranges between Niagara and Kingston.

Surveys had a basic hydrographic orientation. However, many hydrographers were involved in other areas. The James Bay survey staff was involved in an oceanographic program; on Lake Erie, hydrographers worked on a limnogeological program; and locally, staff was assigned to the R&D Section, to work with the Hydrodynamics and Shore Properties groups.

During the latter part of the year, a Tides and Water Levels section was established, to become actively involved in Water Levels and Currents and satisfy navigational requirements.

The Region introduced side scan sonar operations into all major surveys. The sonar unit, with a competent operator, was rotated among the field parties. This system was successful not only in detecting possible navigation hazards, but with exposure to many hydrographers, future potential and operational capabilities were demonstrated. The sonar unit was also used to study sand wave formations on the St. Lawrence with good results.

The instrumentation efforts of the Development Group were directed mainly to side scan sonar, LORAN-C, Integrated Satnav, and Doppler Sonar navigation systems and HAAPS hardware. Data processing concentrated on getting the most from the Gerber 22 plotting system.

A senior hydrographer of the Region was assigned to Algonquin College, Ottawa, to instruct the Hydrography 1 course. Assistance was given to Pacific Region by assigning three experienced hydrographers to the CSS *William J. Stewart* and CSS *Parizeau*.

Two hydrographers took advantage of the University Training Plan, and many others took courses on a part-time basis to advance their technical capacity.

The Cartographic Section, though small, made an important contribution to the Division and Directorate, as did the Marine Information and Hydrographic Data centers. Without the support of other divisions, Hydrography could not function.

ARCTIC SURVEYS

Hydrographers worked on the Polar Continental Shelf Project. A bathymetric survey of Norwegian Bay was completed, partly in response to the needs of the oil companies for improved bathymetry, and partly to ensure the safety of icebreakers enroute

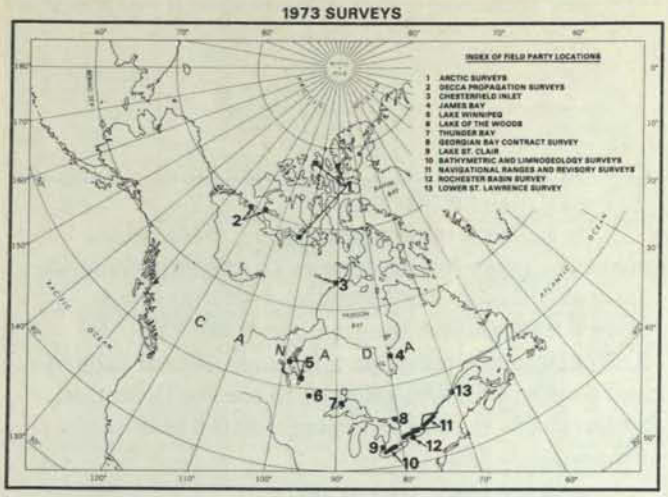


FIG. 2. 1973 surveys by Central Region, CHS.

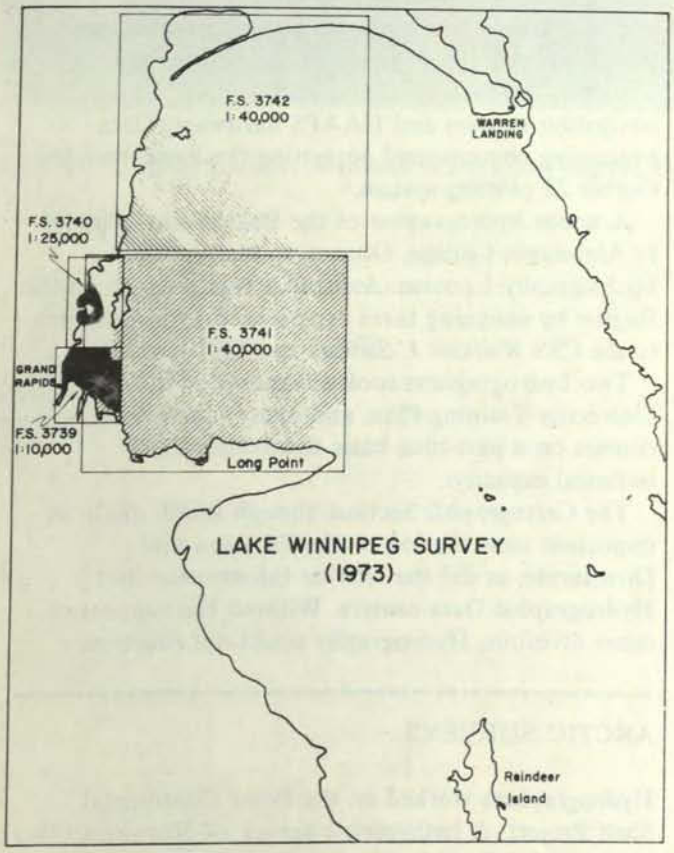


FIG. 3. Lake Winnipeg survey, Grand Rapids area.

to Eureka. This survey used helicopters and through-ice sounding methods. Hydrographers also worked in Amundsen Gulf where a joint Regional/Headquarters experiment was carried out to compare the propagation velocity of DECCA signals over ice-free and ice-covered waters.

James Bay and Chesterfield Inlet

For the second year a successful combined hydrographic/oceanographic survey was conducted in James Bay, and now provides a safe shipping route 5 miles wide from Cape Jones to Fort George. This was a fully automated survey, using the Hydrographic Acquisition and Processing System. (HAAPS). Two oceanographic cruises were conducted in the northern part of James Bay.

In preparation for a major survey, a reconnaissance survey was conducted in Chesterfield Inlet to gain familiarity with the area and establish sufficient horizontal control for sounding operations in 1974.

Northern Icebreakers

Central Region provided two hydrographers for icebreaker service in arctic waters in 1973. Two icebreakers were manned, the CCGS *Louis St. Laurent* and CCGS *John A. Macdonald.* The 1973 navigation season in arctic waters, unlike the previous year, was relatively ice-free and gave CHS an opportunity to gain valuable bathymetric data by track-sounding methods.

The CCGS *Louis St. Laurent* conducted a reconnaissance survey along the west side of Ellef Ringnes Island, east through Belcher Channel, and south through Penny Strait. The CCGS *John A. Macdonald* conducted a reconnaissance probe through M'Clintock and Peel channels, and Victoria Strait.

LAKE WINNIPEG AND LAKE OF THE WOODS

A major hydrographic survey was started in Lake Winnipeg in 1973. The Manitoba Hydro Project on the Nelson River and a developing tourist industry have made modern navigational charts of Playgreen Lake and Lake Winnipeg essential.

The survey used a 50-watt Mini-Fix System and MRB-2 Hydrodist System with all data compiled and protrayed by the Hydrographic Processing System (HYPOS). The hydrographic data collected will enable safe passage of ships for one quarter of the northwest portion of the lake in the area of Grand Rapids.

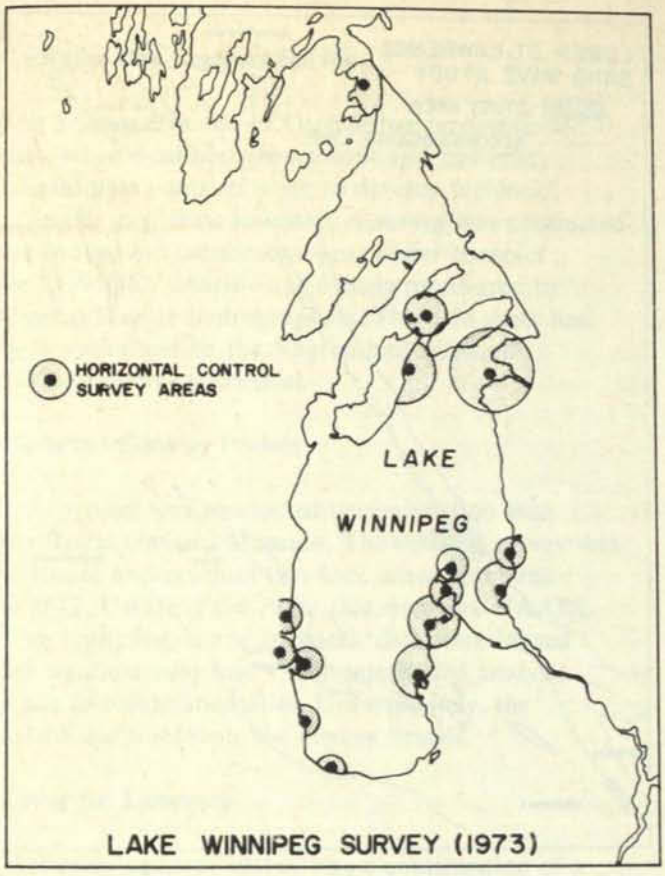


FIG. 4. Lake Winnipeg survey, horizontal control areas.

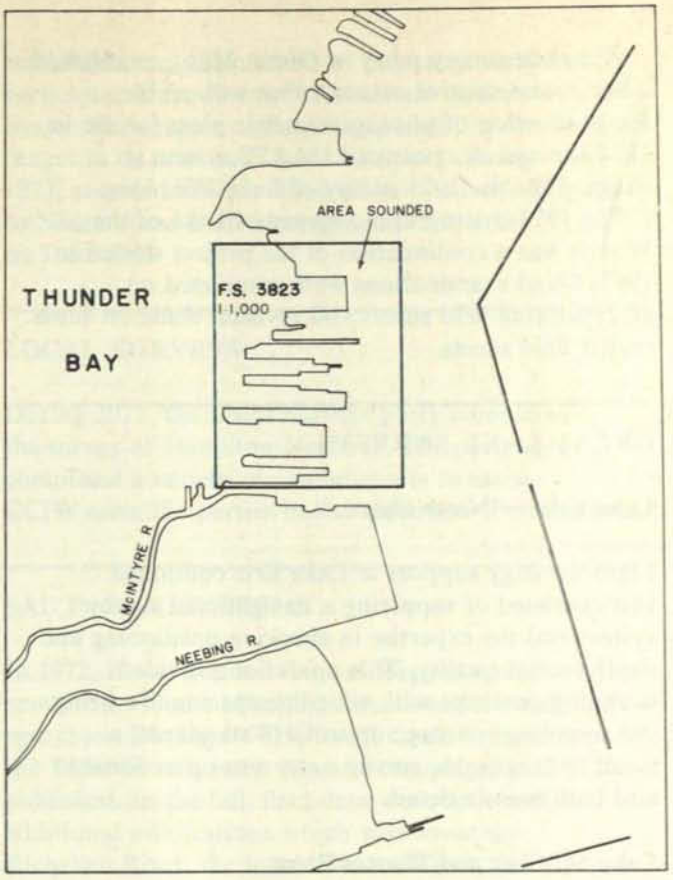


FIG. 6. Thunder Bay sounding area.

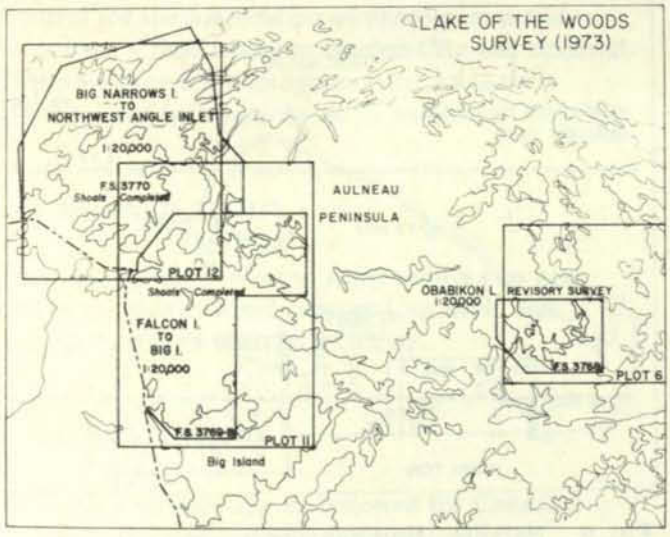


FIG. 5. Lake of the Woods survey.

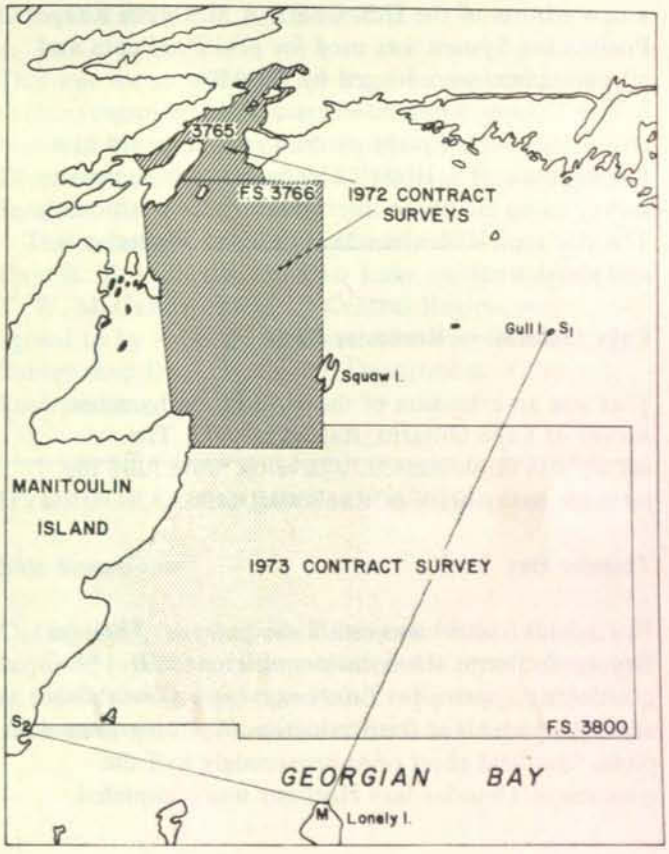


FIG. 7. Georgian Bay contract survey.

A mobile survey party in Gimli, Man., established a horizontal control network that will enable the production of photogrammetric plots for use in 1974 surveys. A revamped HAAPS system is planned for the 1974 survey of Lake Winnipeg.

The 1973 hydrographic survey of Lake of the Woods was a continuation of the project started in 1967. Shoal examinations were completed on all remaining field sheets and revision made on some earlier field sheets.

GREAT LAKE SURVEYS

Lake Erie — North Shore

Limnogeology support in Lake Erie continued and consisted of supplying a navigational survey system and the expertise in checking positioning and depth record quality. This operation provided sounding coverage with wide-line spacing. To bring the sounding coverage up to CHS standards, a small hydrographic survey party was operational to add bathymetric detail.

Lake St. Clair and Thames River

In 1973, priority was given to a survey in Lake St. Clair in a venture with the U.S. Lakes Survey, for a new edition of the U.S. Chart. A Motorola Range Positioning System was used for positional data and all parameters were logged by HAAPS.

The Thames River, used extensively by large cruisers and small pleasure craft, was surveyed at a natural scale of 1:10,000. This was a reconnaissance survey using air-photo interpretation for positioning. The side scan sonar was used to locate obstacles and shoal areas.

Lake Ontario — Rochester Basin

This was an extension of the HAAPS bathymetric survey of Lake Ontario, started in 1972. The survey was implemented to develop more fully the intricate bathymetry of Rochester Basin.

Thunder Bay

Horizontal control was established around Thunder Bay to facilitate the location of electronic positioning systems for future surveys and establish accurate control for the production of photogrammetric plots. One field sheet of approximately half the wharves in Thunder Bay Harbour was completed.

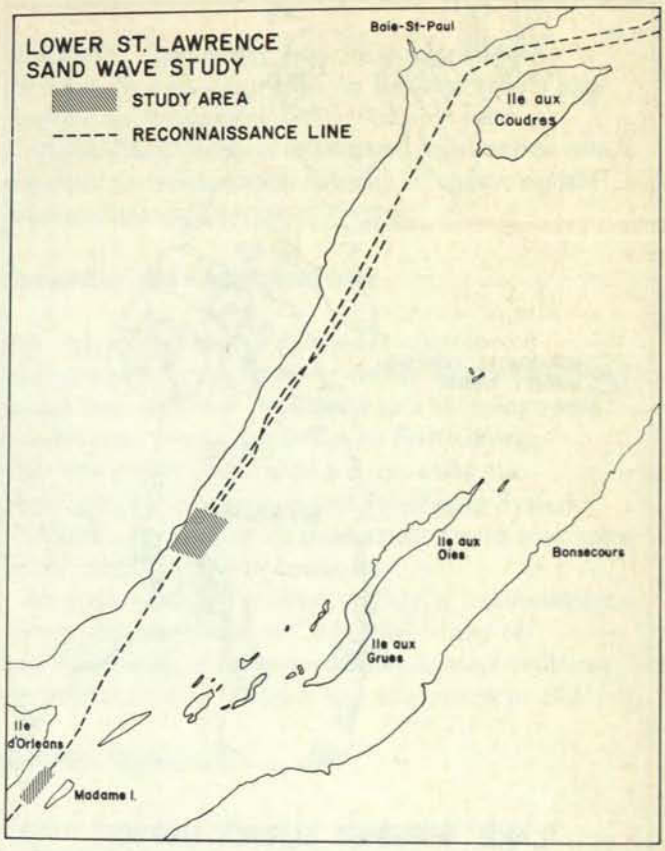


FIG. 8. Lower St. Lawrence sand wave study.

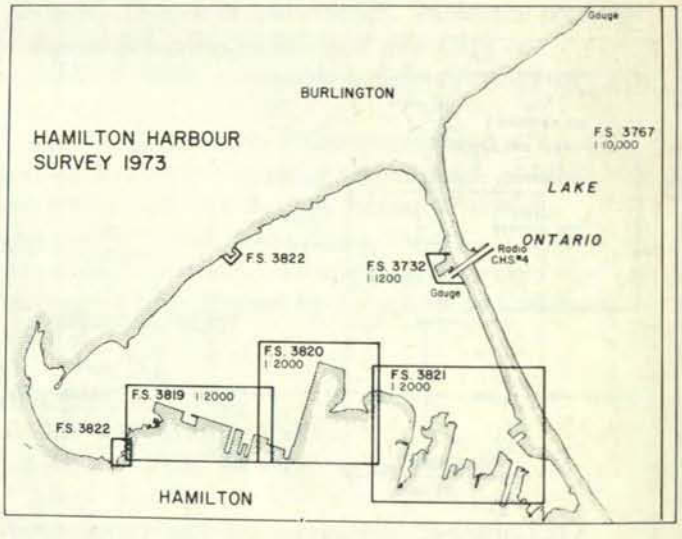


FIG. 9. Hamilton Harbour survey.

Georgian Bay Contract Survey

The Science Council of Canada has recommended that, when possible, government and university laboratories contract work to develop technical expertise in private industry. A survey was conducted for the second consecutive year under contract by COMDEV Marine and closely monitored by Central Region hydrographers. The field sheet has been submitted to the Region and from all indications was successful.

Hamilton Scourge Project

This project was conducted in conjunction with the Royal Ontario Museum. The detailed survey was to locate and position two U.S. schooners sunk in 1812. Utilizing the *Porte Dauphine* and HAAPS, both bathymetric and magnetic data were logged during the survey and a computer-aided analysis made to locate anomalies. Unfortunately, the search did not locate the sunken vessels.

Lower St. Lawrence

This early summer survey was a continuation of a project started in 1969, with the objective of recharting the lower St. Lawrence River from Pointe-au-Père to Quebec City, a distance of 133 miles. Control for the preparation of photogrammetric plots from Crane Island to Quebec City was achieved. This now provides photogrammetric plots for all remaining hydrography as far as Quebec City.

SAND WAVE STUDY

This was a short project to study sand waves near and in the ship channel between Cap Brûlé and Cap Gribane and near Ile d'Orleans.

REVISORY SURVEY

This year's revisory survey followed the Canadian Hydrographic Service policy of systematically updating all existing charts. All charts of the Rideau Canal, lower Ottawa River, St. Lawrence Seaway from Montreal to Kingston, and the Trent River from Trenton to Balsam Lake, were completed.

NAVIGATIONAL RANGES SURVEY

In May, 1968, the Canadian Hydrographic Service accepted responsibility to determine and check positions and true bearings of all navigational ranges established and maintained by federal government agencies and shown on Canadian navigational charts. Each region assumed responsibility for the ranges in its area and Central Region, during 1973, sounded and surveyed all ranges from Kingston to Niagara and a set of ranges at Nanticoke on Lake Erie.

LOCAL SURVEYS

During 1973, the Local Surveys party completed the survey of Hamilton Harbour. The party also completed a variety of commitments to assist CCIW scientific parties in the Hamilton–Toronto area.

SAILING DIRECTIONS

In 1972, it was decided Central Region would produce a volume of sailing directions for small craft operators. During 1973, a Small Craft Volume for the Trent–Severn waterway was completed and published. In the fall, field data were collected for additional publications which will cover the Richelieu River, the lower Ottawa River, and the Rideau Canal.

U.S. TECHNICAL EXCHANGE

This was the second year for the 4-month technical exchange program between the United States National Ocean Survey and the Marine Sciences Directorate, Central Region, Canadian Hydrographic Service.

This arrangement was proposed in 1971 by Capt R. E. Williams, Director Lake Survey Center; T. W. McCulloch, Chief of Central Region, and agreed to by Adm D. A. Jones, National Ocean Survey, and Dr A. E. Collin, Department of the Environment.

HYDROGRAPHIC DEVELOPMENT

Side Scan Sonar

During 1973, an analysis of the sonar field data acquired in 1972 was completed and a report presented at the Canadian Hydrographic Conference. A side scan sonar was purchased and used in a field program.

LORAN-C

Data collected in 1972 with the Internav 101 and the Austron 5000 system was analyzed and the suitability of LORAN-C for positioning research vessels operating on the Great Lakes was determined. A presentation was made to the Canadian Institute of Surveying Conference outlining the results of the analysis.

A 2-week cruise on Lake Superior was used to test the Internav 101 receiver in an operational environment. Data obtained will be compared to navigation data obtained by radar fixing.

A demonstration of a low power LORAN-C slave station manufactured by Megapulse was conducted. The test showed promising range capability but the overall stability of the system could not be demonstrated with the synchronization in the test.

Integrated Navigation System

Plans for a navigation system for CSS *Limnos* were developed for use with the International Joint Commission Upper Lakes Reference Studies. The system has a central computer with inputs from a gyrocompass, a doppler sonar velocity sensor, and a satellite navigation receiver. The system continuously computes the ship's position based on inputs from these sensors and provides steering information to the helmsman as well as a digital magnetic tape record of the ship's track position for post processing. The system requirement was submitted to DSS for lease during 1974–75.

Data Logging and Processing System

A second-generation logging system requirement has been prepared and submitted for acquisition in 1974. Three computer-based logging systems utilizing digital cartridge recorders will be acquired for use on hydrographic launches. A computer processing system with a plotter will be used to produce field sheets as with the present HAAPS system.

Marine Information Centre

During 1973, the Marine Information Centre was relocated and reorganized. The chart and map sales outlet was relocated and integrated with the Public Relations Unit of CCIW The center was renamed the CCIW Information Centre and will combine chart and map distribution with the general distribution of CCIW material. Arrangement of tours within the Centre will also be handled through this outlet.

The unit in which technical data are retained has been renamed the Hydrographic Data Centre. All field manuscripts, field notebooks, control information, and associated data are filed with this unit. Books and publications related to hydrography are retained and other publications sent to the CCIW library after circulation.

Processing — HAAPS, HYPOS, Gerber 22

The Hydrographic Acquisition and Processing System, or HAAPS equipment, appears to have come of age and was used with great success on the James Bay survey, Lake St. Clair survey, Lake Ontario, Hamilton–Scourge Project, and the lower St. Lawrence sand wave study in 1973.

The Hydrographic Processing System was used with reasonable success on the Lake Winnipeg survey during 1973. Slowdowns due to mail service seemed to be the major drawback. No further attempts will be made to use this system for support of major surveys.

The Gerber 22 Plotting System produced numerous lattice sheets for both Central and Atlantic regions. It was used extensively for preparing HYPOS sounding plots and for producing final field sheets for James Bay, Lake St. Clair, Lake Winnipeg, and Norwegian Bay.

Atlantic Region

INTRODUCTION

The Hydrography Division is one of five program divisions within the Atlantic Oceanographic Laboratory, and is responsible for all matters pertaining to hydrography within the Atlantic Region. The region is defined as Canada's Atlantic Seaboard, extending west to Pointe-des-Monts, Que., and north to include Canada's eastern arctic, excluding Hudson Bay.

To fulfill its regional and national responsibilities the division is composed of four sections. Charting, the largest, has the responsibility of planning and conducting field surveys, reviewing, checking, indexing, storing, and promulgating nautical data. Development is concerned with developing and implementing new technology into the field side of hydrography. Navigation undertakes exhaustive studies in navigational equipments and techniques and the implementation of innovations to the marine environment. Tidal has the responsibility for all tidal matters pertaining to the division. This section also maintains an inventory of tide gauges for use by those concerned with measuring tidal phenomena.

The 1973 field program proceeded exceptionally well considering that, of the seven field establishments in operation, only two were supported by Department of Environment vessels. Three chartered vessels were utilized for surveys around the Atlantic Provinces, one Ministry of Transport icebreaker was utilized in the eastern arctic for intermittent periods, and the seventh establishment consisted of a large shore-based operation in Nova Scotia. In addition to standard nautical charting, the division engaged in a continuing cooperative program with the Atlantic Geoscience Centre of the Department of Energy, Mines, and Resources in mapping the natural resources of the continental margin. In this activity, four parameters are measured systematically – bathymetry, gravity, magnetics, and seismic reflections.

At the beginning of 1973, there were 51 full-time continuing and 2 term employees on strength. This increased to 52 full-time continuing and 10 term employees at the peak of the field season. During the year there were some fluctuations in staff strength caused by resignations. The most important change in staff was the resignation of L. A. Foster as Regional Tidal Officer. A personnel highlight was the recruitment of Bernadette Flemming, the first female hydrographic field officer to serve in CHS. R. G. Burke is acting head of the Hydrographic Development Section, and D. L. DeWolfe, a 1973 UTP graduate in mathematics and physics, is Acting Regional Tidal Officer.

During the year, the division became involved in two new programs — a cooperative student program with the Surveying Engineering Department of the University of New Brunswick, in which on-the-job training will be provided for at least one, and perhaps two, undergraduates during future survey seasons; and planning and management of a major combined Canadian Hydrographic Service training and production-charting operation of the coastal waters of Guyana, South America, under the auspices of the Dominion Hydrographer, G. N. Ewing, and the Canadian International Development Agency (CIDA).

Many members are undergoing training for extensive periods. Eight new field officers are taking Hydrography 1 training, and four others are attending university full time — three in undergraduate studies and one in graduate studies.

CHARTING

The charting program of the Atlantic Region included several important surveys in 1973. The CSS *Baffin* returned to the arctic region, after an absence of 11 years, to conduct standard hydrographic surveys. The surveys were successful and included a significant amount of geophysical and geological sampling that created a second survey establishment, heavily engaged in multidisciplinary programs. Both surveys engaged in multidisciplinary programs were cooperative ventures involving the Atlantic Oceanographic Laboratory, the Atlantic Geoscience Centre, and the Terrain Sciences Division of the Department of Energy, Mines, and Resources.

The introduction of new instrumentation to the field programs had an important impact on survey results. The HAAPS system operated extremely well and allowed preliminary processing to be kept up-to-date, without impeding the data-gathering process. This fact is important in the arctic where operational time is limited.

The introduction of combined navigation systems, LORAN-C and Satellite Navigation, to operate with the Lambda positioning system and the new Hewlett Packard 2100 computer systems for operation on the offshore multidisciplinary surveys,

had a positive influence on production. Vessel transit time to and from reference buoys and the assurance of correct positional data in the far offshore areas were the primary reasons for these gains and it was estimated that an increase in production of 10–15% could be attributed to this instrumentation.

Side scan sonar started to play an active role in the charting programs and was readily accepted as a field surveying tool. Other advances in depth-determining instrumentation (i.e. high resolution recorders, deep-sea digitizers) combined to provide high quality data.

Short-range, electronic positioning systems have played an ever-increasing role in the conduct of coastal charting. The introduction of Mini-Range systems to the route surveys of the Labrador coast made a noticeable increase in output.

A third charter vessel was added to the resources of the region in 1973 to fill the vacancy created by the return of CSS *Kapuskasing* to the Department of National Defence. Approximately 40% of the staff engaged in hydrographic programs are now operating from chartered vessels.

These facts, plus reasonably favorable weather conditions and excellent technical support, resulted in a successful season.

Field Activities

Surveys were conducted by seven establishments involving departmental ships, charter ships, a Ministry of Transport icebreaker, and a shore-based party. CSS *Baffin* and CSS *Maxwell* were the departmental vessels from which surveys were conducted. Three vessels, the MV *Minna* (2354 tons gross), the MV *Theron* (849 tons gross), and the MV *Christmas Seal* (149 tons gross) were chartered for the survey season. The CCGS *Labrador* of the Ministry of Transport was used for surveys in the arctic. A large shore-based party operated throughout the season supported by a number of 8- and 10-meter survey launches and land vehicles.

The CSS *Baffin* commenced field operations May 15 in the St. Lawrence River Estuary. The survey involved standard coastal charting, a multidisciplinary survey of the Estuary proper, and a continuation of a detailed harbor survey of Sept Iles started in 1972. Positioning of both HAAPS equipped launches and the vessel was controlled by Hi-Fix. The use of HAAPS on this survey marked the first time the system was used in a truly operational sense with no manual "backup" system required. Three new wooden survey launches of the displacement type were used on the vessel. The launches are based on the hydrographic launch design of the late 1950s with improvements to the cabin area and increased propulsion power. After some initial problems these launches functioned extremely well throughout the remainder of the season. The launches operated at speeds in excess of 16 knots and were fully instrumented with data loggers and radar in addition to standard positioning and depth-determining instrumentation. A current measuring program was carried out in the approaches to Sept Iles to provide data for shipping in the area. Unfortunately, because the current meters did not remain in position, no useful data was obtained. After completing a portion of the St. Lawrence Estuary Survey, the vessel departed for the arctic July 16.

En route to the arctic, targeting of previously established control for aerial photography in the Hopedale, Labrador, area and a control and reconnaissance sounding survey in the Cape White Handkerchief, Labrador, area were undertaken. The primary survey areas in the arctic were Lancaster Sound and Maxwell Bay. The survey of Lancaster Sound was primarily to complete charting of the eastern portion of the Northwest Passage and to provide information for possible pipeline routes. In addition to the Hi-Fix controlled bathymetry, gravity, magnetic, and reflection seismic data were acquired. Some camera stations and a large number of shallow core stations were also obtained. The Lancaster Sound survey was approximately 65% completed. The Maxwell Bay survey was to provide information on the possibility of using this location for a pipeline terminus. The survey used mainly survey launches. The vessel then returned to the Sept Iles area to complete the charting of this high shipping volume port.

The CSS *Maxwell* was involved in coastal charting plus a number of chart revisory projects during 1973. The projects, resulting primarily from internal priorities and requests made by the Ministry of Transport, were spread throughout the Atlantic Provinces. The survey began in the Bay of Chaleur where a number of chart revisory, wharf, and harbor surveys were required. After completing work in the Bay of Chaleur area, surveys of Alberton and Rustico, P.E.I., were carried out and a chart revision made of Charlottetown, P.E.I. The vessel also gathered data and completed several surveys in the Fogo Island area of Newfoundland. This involved shoal examinations in Change Island Run, a survey of Stag Harbour Tickle, and various small projects near Musgrave Harbour. A survey of Trepassey and St. Mary's Bay, Nfld., started in 1972, was continued. Survey of this area was to complete the relatively unsurveyed portion between two existing navigation charts. Using a Range Positioning System the survey of Trepassey Bay was completed as far as St. Shotts. Current meters were moored to obtain near-surface horizontal movements of water in the area. The *Maxwell* completed the season

with several small projects: a shoal examination at Come-by-Chance, Nfld., a wreck examination at Lawn Bay, Nfld., a wreck examination and chart revision at St. Pierre (France), and a range survey in the Strait of Canso.

The MV *Minna* was chartered for a 4-month period to continue the multidisciplinary charting program which, by 1973, had progressed up the Atlantic seaboard to the northeast Newfoundland Shelf. The methods and instrumentation used on this survey have been reported in many papers. Many improvements were made to the operation. The water depths in the northeast Newfoundland Shelf area prohibited mooring of reference buoys for the commonly used Lambda positioning system except in near-shore areas. In addition to the mooring problems, a portion of the survey area was out of usable coverage provided by the Lambda system. These two problems were solved by the use of a combination of Lambda, Rho-Rho LORAN-C, and the Satellite Navigation System.

The Lambda system was used in relatively near-shore areas and the Satellite Navigation System provided lane identification. In areas of poor Lambda coverage, Rho-Rho LORAN-C was used as a primary positioning system with the Satnav System providing calibration data for LORAN-C. Combining these positioning systems worked extremely well and preliminary estimates are that production increased about 10–15%. Another improvement was the acquisition of portable labs that can be lowered with all equipment installed into the hold of the vessel. One unit holds all the instrumentation and watchkeeping areas and the second unit houses the hydrographers' drawing office and technicians workshop. These units made an efficient working environment as well as a rapid loading and offloading facility. Near completion of the charter period, a number of lines of reflection seismics were run, but severe sea conditions made data somewhat difficult to obtain. As a departure from past years the maintenance and watchkeeping at the Lambda slave stations was carried out by contract to private industry.

The MV *Theron* was charted for a 3½-month period to continue the route surveys of the Labrador coast. he : oute surveys between Hopedale and Nain fulfill an urgent requirement by the Newfoudnland Ship Owners Association. Four standard hydrographic survey launches and other hydrographic equipment were fitted. Unfortunately, the survey was hampered by numerous mechanical breakdowns of the survey launches and problems with modifications made to the vessel. However, a route has been completed through to Nain although some shoal examinations are still required at the extreme north end. Current measurements were obtained in the critical areas of the routes. In the early part of September, the vessel proceeded to the Hare Bay area of Newfoundland to resolve a discrepancy between the British Admiralty chart and the existing topographic maps. Upon completion of the Hare Bay project, the vessel moved to Lewisporte, Nfld., to start work on the approaches to this area where little hydrographic information exists. The survey control for this area was completed.

The MV *Christmas Seal*, chartered for 5 months, carried out chart revisory and navigational range surveys along the south and west coasts of Newfoundland and the Maritime Provinces. All charts between Grand Bank and Pistolet Bay, Nfld., were revised. The vessel then proceeded to Sydney, N.S., to carry out a cyclic chart revision of the port and survey a number of wharves at the request of the Atlantic Pilotage Authority. A survey was made of harbor approaches to Richibucto, N.B., at the request of the Ministry of Transport. A survey of the entrance to Pictou Harbour, N.S., was undertaken to determine if depths were gradually decreasing due to silting. Surveys of various wharves in the Strait of Canso were also completed at the request of the Atlantic Pilotage Authority, with a chart revision of this active shipping area.

A shore party was established in the Jeddore, N.S., area to continue charting the coastal waters of Nova Scotia. This survey, supported by Mini-Ranger positioning systems, progressed westerly from Nichol I to Long I. Current measurements were taken by moored meters in this area. With the cessation of reasonable weather near the latter part of July, a survey at Bras d'Or Lake was conducted to satisfy a navigation and recreational chart requirement. This survey was supported by a variety of launches and motor vehicles. A Bertram launch fitted with gasoline-driven, Hamilton jet propulsion system, was assigned for evaluation purposes. The launch was used successfully in shallow water areas. A second Bertram launch was fitted with a Cummins diesel engine and V-drive system, also for evaluation. This launch worked extremely well in this area with the exception of the vulnerability of the propeller and rudder arrangement. Mini-Fix positioning was used in two different locations to cover the lake proper and a portion of East Bay.

The CCGS *Labrador* carried a small team of hydrographers to chart on an opportunity basis in the arctic regions. This survey had a successful season and completed a high priority survey in the Little Cornwallis Island area to aid shipping in the development of a lead–zinc mine. Ice conditions were exceptionally good in this area and a number of blank areas on existing charts were filled in. A survey of a new wharf facility in Deception Bay, Que., was partially completed.

In addition to the above surveys, many projects were undertaken by hydrographers operating directly from the Institute. Such projects were requested by other divisions in the Institute, government departments, and industry for shoal examinations, wreck surveys, post-dredging surveys, new waterfront construction, and revisory surveys. One project was a request by the city of Dartmouth for a survey of lakes Banook and Micmac, to fulfill a recreational charting requirement in anticipation of the World Canoe championships to be held in 1978.

Training

The training program continued at a high level during 1973, with field staff members involved in the Hydrography I course. The introduction of new equipments to the field program made many short, in-house courses necessary to make hydrographers aware of the principles, capabilities, and operating procedures involved.

Multidisciplinary Surveys

In collaboration with the Atlantic Geoscience Centre, the Atlantic Region performed detailed marine geophysical measurements in three areas during the 1973 field season.

Continental Shelf

The major effort was mapping the gravity and magnetic fields of the Continental Shelf and margin northeast of Newfoundland. For the second consecutive season, the motor vessel *Minna* was chartered by the Atlantic Oceanographic Laboratory and fitted out as a hydrographic–geophysical survey vehicle. Equipped with echo sounder, gravimeter, and magnetometer, the ship obtained continuous coverage at line intervals of $2\frac{1}{2}$ nautical miles in depths of less than 1000 meters, 5 nautical miles in depths to 3000 meters, and 10 nautical miles in depths exceeding 3000 meters. For part of the survey season, the ship also had a seismic capability; 40- and 300-cubic inch airguns and a 4-section hydrophone streamer were used to obtain reflection profiles concurrently with the acquisition of other types of data at intervals of 20 nautical miles. Through a combination of satellite navigation, 2-range DECCA 12F, and Rho-Rho LORAN-C, ships' positions were determined to an accuracy estimated at ± 200 m anywhere within the survey area.

St. Lawrence Estuary

Gravity and magnetic data were also collected aboard the CSS *Baffin* in conjunction with hydrographic surveys in the St. Lawrence Estuary and Lancaster Sound. In both areas, limited coverage was obtained at line intervals of $\frac{1}{4}$ and $\frac{1}{2}$ nautical miles, depending on water depth. Ships' positions were determined by means of Hi-Fix hyperbolic. In the Lancaster Sound area, a seismic profiling capability was added to the operation to obtain surficial data in support of land-use studies in the region, and to evaluate the feasibility of incorporating this type of activity into routine hydrographic surveys in the arctic. Two EMR scientists, D. I. Ross of the Atlantic Geoscience Centre and C. F. M. Lewis of the Terrain Sciences Division, were aboard for this phase of the cruise.

On both vessels, the major responsibility for field activities rested with hydrographic personnel, who were charged with the operation of gravimeters and magnetometers owned by the Atlantic Geoscience Centre, in addition to standard echo-sounding equipment. The same personnel also performed the routine computer processing of geophysical data on board ship for preliminary verification and quality control, and ashore for final checking and archiving. The production by computer of contour maps of geophysical parameters will be contracted to a data processing firm working under EMR supervision. EMR participation in the project is generally restricted to one professional working in a consultative and advisory capacity, and the technical support required for project mobilization and maintenance of geophysical equipment in the field.

Information collected during these surveys will be added to the data bank which is available to AGC scientists and others working on problems related to the geology and geophysics of the eastern Canadian seaboard. In addition, the bathymetric and potential field data will be issued as maps in the Natural Resource Series, published by the Marine Sciences Directorate, Department of the Environment.

Experience was gained on the *Minna* in the use of the Hewlett–Packard 2100 computer equipped with a moving-head disc. This system increases shipboard computing power by an order of magnitude, and permits the field processing of data to a much more advanced stage than was previously possible. On the *Baffin*, HAAPS (automated bathymetric logger) and BIODAL (geophysical data logger) were carried out concurrently for the first time, and some software development was undertaken to achieve a measure of compatibility between the two systems.

HYDROGRAPHIC DEVELOPMENT

The Hydrographic Development Section is comprised of two electronic engineers, one technician, and

an hydrographer on rotation. The fundamental task of this section is to develop and implement new techniques to advance the art of hydrography. During the past year, development personnel were busy with software development, circuit design, equipment evaluations, and technical training.

Side Scan Sonar

An EGG Mark 1A side scan sonar has been acquired by the Canadian Hydrographic Service, for reconnaissance and special purpose survey work. Careful interpretation of the analogue sonographs produced by the system provides information on bottom irregularities and navigational hazards. These records provide a detailed picture of underwater structures that would be impossible to obtain from conventional soundings. In early spring, a Canadian Armed Forces Sea King helicopter was lost 80 kilometres off the coast of Nova Scotia. Within a few days, Hydrography's sonar was brought into the search.

A systematic reconnaissance of the area was carried out, directed by Dr D. L. McKeown, Metrology Division, AOL. As the search progressed, several likely targets were spotted on the sonographs. The targets were examined in closer detail by rotating the transducer 90° and using the system as a narrow-beam, high-resolution vertical sounder. This technique narrowed the suspected targets to the missing helicopter.

The side scan sonar, in the hands of competent personnel, can be a valuable tool. The initial search area was in excess of 25 square miles with water depth to 200 meters, so the successful ending may be compared to finding a needle in the proverbial haystack. The project had many beneficial spin-offs. Hydrographic personnel assigned to the project gained valuable experience in the operation of the side scan sonar. Almost identical techniques would be used to look for navigational hazards in shipping lanes. The sonographs from the search area proved to be of good quality and the Atlantic Geoscience Centre has awarded an interpretation contract to Geomarine Associates Ltd.

A second opportunity came when a 2-day search, using conventional techniques, failed to locate a missing current meter. The meter, moored approximately 7 meters below the surface, was located in less than an hour using the EGG side scan sonar. Valuable operational experience was gained by examining a wreck located in Halifax Harbour. The closeness of this wreck to the Bedford Institute of Oceanography docksite will make it a useful target for training purposes.

A number of highly detailed sonographs were obtained when the system was used during the Sept Iles docksite survey by the CSS *Baffin*. These records complemented the conventional survey as no new navigational hazards were discovered. Figure 10 shows one sonograph from this survey.

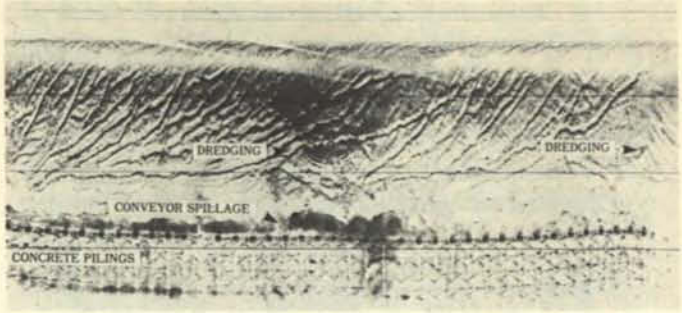


FIG. 10. Iron ore dock, Pointe Noire, Que., from which iron ore pellets are loaded. Evidence of past dredging is shown in the two marked areas. The main loading facility is located near the center of the dock and the dark patch is probably the result of spillage from the conveyor belt.

HAAPS

The Hydrographic Acquisition and Processing System (HAAPS) was used during the Sept Iles and Lancaster Sound surveys by CSS *Baffin*. Four logging systems and a computer were used to log and process in excess of 9500 kilometers of sounding line data. Last year was the first time the equipment had been used in the arctic.

Modifications carried out by the Hydrographic Development Section prior to the 1973 field season improved the performance of the equipment. The depth digitizers were changed to increase the reliability of depth digitization and to ensure that fixed record lengths would be recorded on magnetic tape. Software has been developed to permit additional sounding to be plotted between selected depths when space exists. This resulted in a higher and more consistent density of soundings plotted on the field sheet compared to previous years. Figure 11 shows a portion of one of the Sept Iles field sheets produced by HAAPS.

HAAPS performed well during the season and little maintenance was required. Some problems

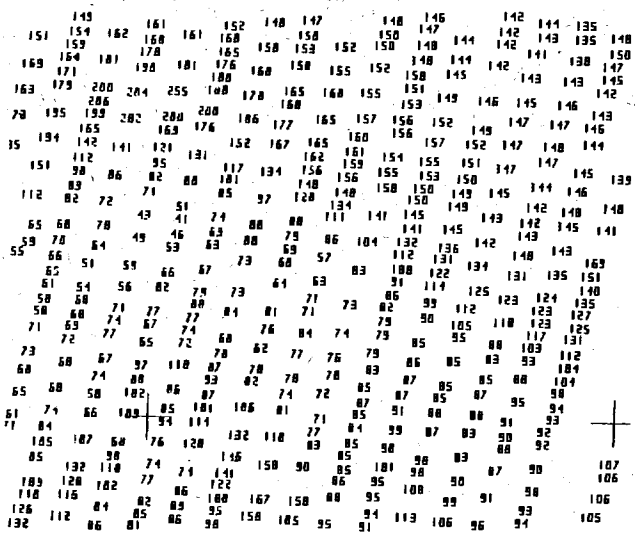


FIG. 11. HAAPS field sheet.

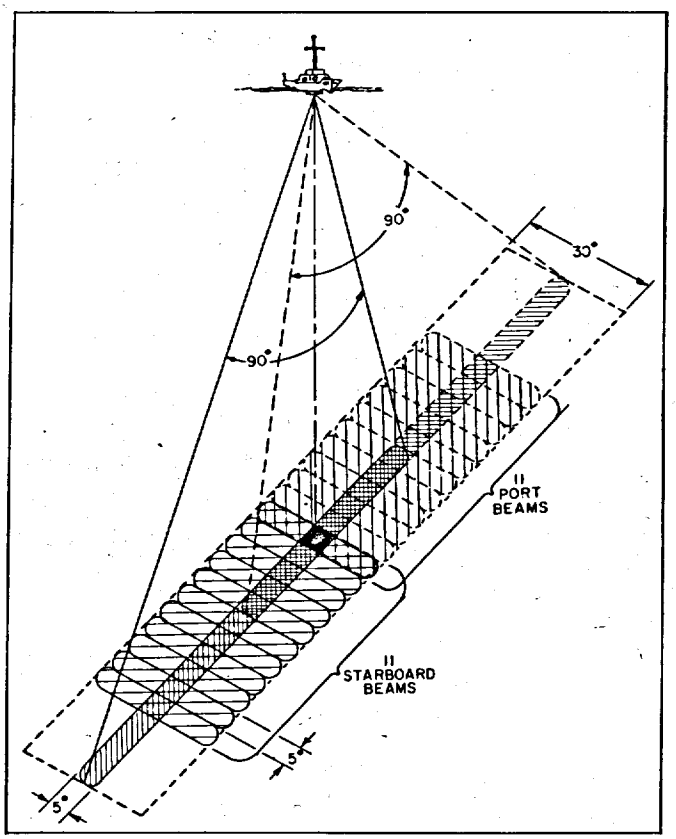


FIG. 12. Bo'sun multibeam sonar.

were encountered, one with the Calcomp plotter. Sticking and blotching of the pen led to poor quality numbers plotted in many instances. New inks, pressurized pens, and various paper types are under investigation by the Hydrographic Development Section in an attempt to eliminate this problem. Processing time is scale-dependent and turn around time on larger scales has proved to be a bottleneck in processing. Also, editing vast amounts of data via paper tape and teletype is slow. Conversion of the HAAPS software from the PDP-8 computer to an HP 2100 system, equipped with disc and line printer, is near completion. Significant improvements in both processing time and capability should result from a larger computer system. Careful studies of both systems will be required to determine which is best at the least cost.

Bo'sun Multi-Beam Sonar

A Bo'sun Multi-Beam Sonar System was evaluated in the fall of 1972. The system was used to survey a portion of the Bedford Basin so results could be compared with an earlier conventional survey. Twenty-one individual beams were employed to make slant-range measurements from the ship's transducer to bottom. Coverage was approximately 2.6 times depth (Fig. 12).

The 21 adjacent slant-range measurements, perpendicular to the ship's track, were digitized and recorded on magnetic tape, with navigational data. Software was available to edit, process, and generate a contoured bathymetric chart from the data.

Results from the evaluation survey are shown in Fig. 13. Figure 14 was produced from a conventional survey of the same area carried out in previous years. The two contour charts are in good general agreement. Approximately 2 hours central processor time, 8 hours peripheral processing time, and 5 hours plotting were required to generate the contour chart. Contour lines were labelled by hand and no software was available to select and plot deeps and shallows on the sheet.

It has been decided not to purchase a Bo'sun system. Some hardware and software development would be required before stringent requirements of CHS could be met. The cost ($125,000) and requirements for specially trained personnel to operate, maintain, and process the data present additional problems. From a long-term point of view the Bo'sun system holds great potential. It offers the advantage of increased bottom coverage and provides the end product in the form of a contoured bathymetric chart.

Arcon Contouring Package

A contouring program, written by the Arcon Corporation of Wakefield, Mass., is unique as it will operate on a minicomputer such as the Hewlett–Packard 2100A. A maximum of 2000 data points can be contoured in approximately 4 hours using a machine with 16 k of memory, disc, and magnetic tape. The program uses a triangulation technique to generate the contour lines.

The capabilities of this program fall short of the requirement to contour a field sheet of 20,000 soundings. Work has been carried out by the Development Section to modify the package so segmentation of data can be implemented and to convert data storage from magnetic tape to disc and improve processing speed. The lack of an HP 2100A system for software development has delayed progress on this project and it will be some time before all modifications can be made and evaluated.

Hydrographers employ somewhat different rules for contouring; consequently, the manual and computer-generated contours do not always match. Modifications to the aglorithm, which will produce results more in accord with conventional methods, are under investigation.

Miscellaneous

A variety of miscellaneous projects was carried out by the Hydrographic Development Section in 1973. One project included the design of a remote readout kit for two Motorola Mini-Ranger positioning systems. Mini-Ranger has only one display for both ranges and this creates an inconvenience for the hydrographers and coxswains. The remote readout kit provides a display for the second range and a remote readout which can be used by the coxswain to monitor the range being run.

Four semiautomatic sounding scalers have been modified for use with the metric EDO 9040 depth sounders. All tide and velocity corrections are applied in metric units.

An automatic fixing unit was tested last winter. The unit will be able to fix on time or lane intervals. Both position patterns are read between fixes and the depth sounder will be marked at each fix.

New application programs have been written for field use. One program is a range–range lattice plot several times faster than an earlier version. A routine has been written to plot error lobes for range–range positioning lattices. The increased use of portable shortrange positioning systems created a requirement for this software.

A portable field sheet reproduction kit has been built and tested. In less than 5 minutes, it is possible to obtain a relatively good quality reproduction from a 1-foot square section of a transparent field sheet. The kit is simple, essentially consisting of a light bulb, ozalid paper, and ammonia.

A self-righting tide staff was tested during the Lancaster Sound survey. The experiment was a partial success; the major problem was an insufficient righting moment on the staff. A new unit will be fabricated and tested in 1974.

NAVIGATION GROUP

The Navigation Group ensures that BIO's survey and scientific cruises are served by the most appropriate navigation available. As this is the only such group in Canada, work extends beyond the BIO to some extent. Navigation systems to match BIO requirements are adapted and developed, advice is given on problems, solutions are devised, operators are trained in new methods, and research and development in navigation is carried out.

Radio Wave Propagation Velocity Studies

The Navigation Group has a long standing in this fundamental aspect of radio aid accuracy. Data is collected on cruises specifically planned for the purpose, and when the opportunity arises.

Hi-Fix Lags

A 3-week test, in collaboration with the Nautical Geodesy Section of the Hydrographic Service, investigated phase lags at 1900 kHz by comparing Hi-Fix ranges measured over sea water with geodetic distances found, by simultaneously fixing the ship from high order CHS control points on shore. BIO Engineering Services intalled the Hi-Fix master in the CFAV *Sackville* and slave stations at Western Head and near Chebucto Head, on the concave Atlantic coast of Nova Scotia. CCIW lent a two-range hydrodist system (range accuracy ± 2 m), operated by the Navigation Group to fix the ship at calibration points. The test, planned for April, was interrupted twice by DND requirements for the *Sackville*, so less time was available than was originally expected, but comparisons were obtained at eight distances, ranging from 10 to 180 km from the slaves. Preliminary calculations showed differences of 10–20 meters between Geodetic and Hi-Fix distances. The additional control surveys needed to fix control points have been done, and final analysis is being completed.

Effect of Sea Ice on Lambda DECCA

The Dominion Hydrographer, G. N. Ewing, suggested that BIO Navigation and Positioning System groups collaborate with Central Region and Nautical Geodesy in two series of observations on the Amundsen Gulf Lambda chain. The aim was to measure the change in propagation velocity between continuous ice-cover and open water conditions. Two monitor sites were chosen because of the all over-water path between them. In April hyperbolic readings were taken when Amundsen Gulf was uniformly covered with sea ice about 2 m thick, and again in August when the ice had moved out. The small change in hyberbolic readings recorded indicated a reduction in velocity of the order of 1 part in 2000 due to sea ice. The hydrographic party and Geodetic Survey of Canada also positioned the DECCA transmitters and monitor sites by Satnav and conventional survey to determine the absolute velocity. The data is being analyzed by Nautical Geodesy.

Overland Errors in Main Chain DECCA

Navigation aids, particulary DECCA, are widely used by scientists, often in areas surrounded by land. The Navigation Group is accumulating data on overland errors, to make corrections for particular locations and to investigate whether errors can be more generally predicted. The Atlantic Geoscience Centre program in Canso Strait provided the opportunity to make 60 fixed error measurements between Eddy Point and Port Hawkesbury.

The results, given in a preliminary report by N. Stuifbergen, show errors to 0.24 lanes, which result in position errors to 600 meters. A particularly rapid change in error from -0.17 to ± 0.20 red lanes over 6 km may be associated with changes in proportion of land and water in the path of the signal crossing Bras d'Or Lake.

DECCA *Stability Test*

Thirty-six hours of continuous recording of the red pattern at St. John's, Nfld., in July, showed high stability (± 0.01 lanes) by day but large variations, of ± 0.20 to as high as ± 0.50 lanes, from an hour before sunset until an hour after sunrise. St. John's is about 75 miles from the master transmitter and only 15 from the red slave.

Overland Errors in LORAN-C

A summer student, J. E. Hagglund, did further analysis on overland errors in Rho-Rho LORAN-C ranges measured off the Labrador coast, by comparison with Satnav fixes. He found that by assuming an average ground conductivity of 0.05 mho/m he could compute corrections making the LORAN-C range agree with the Satnav to a standard deviation of $\pm 0.36\ \mu$ (± 100 m).

Satellite Navigation (Satnav)

The Canadian Marconi Company offered the first Canadian-made Satnav receiver at the end of 1972. It was evaluated in a brief ad hoc cruise in December, purchase recommended, and the contract administered for developing on-line software for use at sea. The receiver was delivered in mid-March, and operated flawlessly in three ships. Hydrographers on the *Minna* survey collected data for an accuracy evaluation against Lambda DECCA; preliminary results indicate agreement of better than ± 100 on good passes, using accurate course and speed from DECCA.

This accuracy, if proved by thorough analysis, means that Satnav is precise enough to be used to calibrate radio navigation aids such as DECCA or LORAN-C.

Modern Satnav software provides alerts on-line, but only satellite by satellite. A new and convenient program giving time-ordered alerts for all satellites, written by D. E. Wells, has been prepared for PDP8 and HP 2100 computers.

Satnav/Rho-Rho LORAN-C

The development of the system was halted in the spring, a user's handbook completed, and operators trained. The system was in use throughout the summer in three ships involved in geophysical research on the Scotian Shelf and Labrador Shelf, and in hydrographic and natural resource charting on the northern and southern Grand Banks.

*Satnav/*DECCA *Lane Identification*

The necessary programs were written and hydrographers on the *Minna* survey made lane identification by Satnav (an idea pioneered by Shell Canada Ltd., in 1970). The method worked well; nearly all good passes gave reliable lane identification, and lengthy trips to lane-check buoys were eliminated, saving many hours. Satnav checks have the added advantage of verifying the locking constant and phase lag corrections applied in the survey. Further analysis may indicate that Satnav is capable of Hi-Fix lane identification.

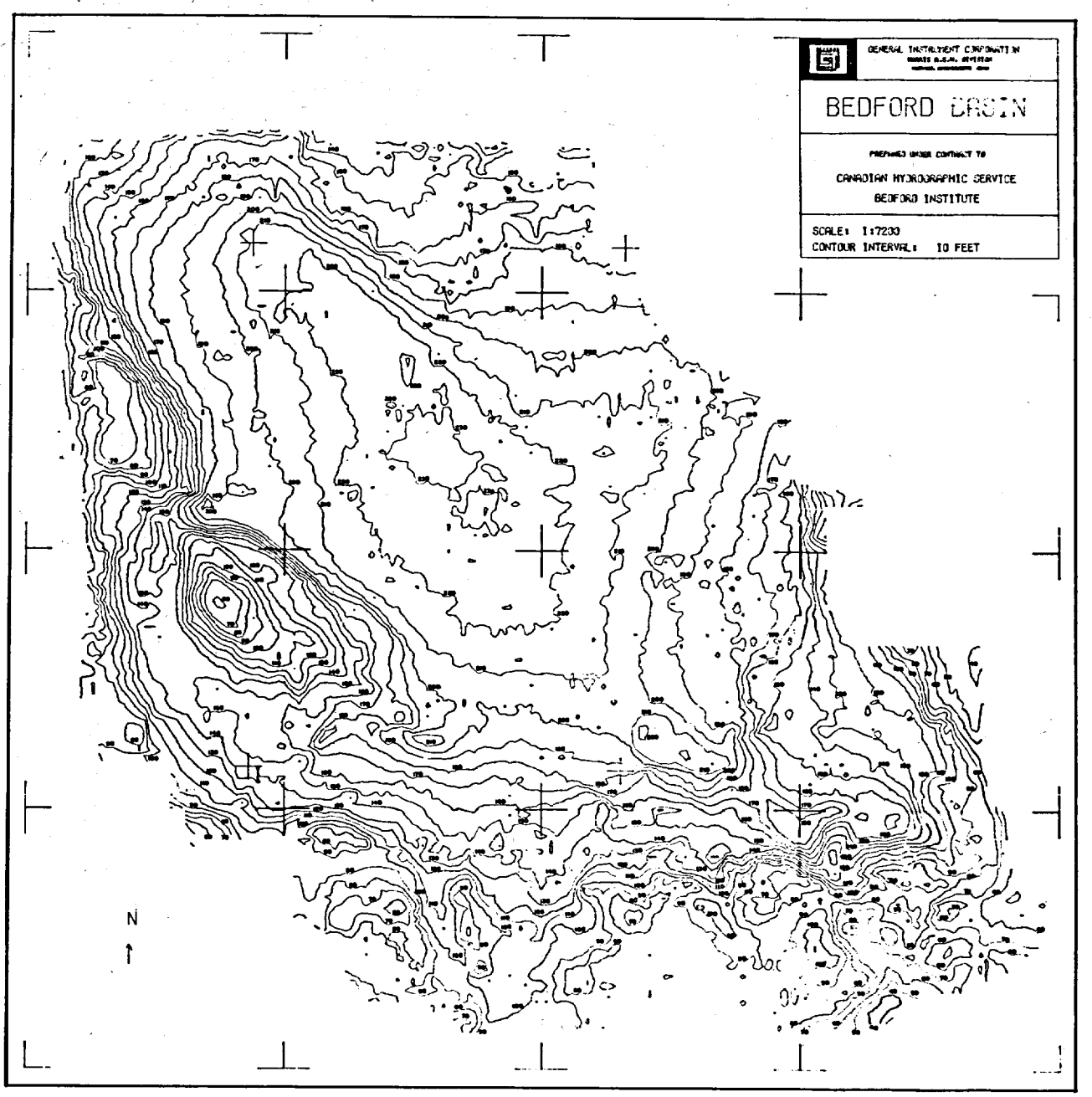


FIG. 13. Bo'sun contour chart.

Satnav/Doppler Sonar

Navigation Group keeps contact with other groups working in navigation, and an offer of a seagoing demonstration of the Magnavox Satnav/Doppler navigator, operated in the *Mary B VI* by Dabbs Control Surveys for Mobil Oil Canada Ltd., was accepted. The job was to recover an abandoned drill rig site 220 km east of St. John's, Nfld., and on one of the first lowerings the search TV camera found cans from the old rig. Evidence that this may not be pure luck was that the difference between Doppler Navigator and Satnav positions amounted to only a few tens of meters. However, weather conditions were ideal and the system had been carefully calibrated. Within its limitation of water depth (<200 m), this is an impressive system.

Acoustic Navigation

When out of range of direct-wave measuring methods (such as RPS, extended range Shoran), acoustic navigation by seabed sonar transponders is the only high precision positioning method available. The BIO Meteorology Section and Navigation Group tested the precision on *Baffin*'s Caribbean cruise in February 1973. There, transponders were laid in 1000–2000 m depth (to get good horizontal range) and the ship still had line of sight to RPS transponders on shore. The RPS accuracy was estimated to be ±10 m, but meteorology was getting agreement to about ±5 m, so the error of RPS was apparently overestimated.

Omega

Omega has a bad reputation, but there will be many areas where it is the only continuous navaid available. A Tracor 599 receiver was taken out in *Minna* for 6 weeks, running it Rho-Rho on the cesium frequency standard and comparing it againt Rho-Rho LORAN-C and DECCA. The aim was to check reliability, geographical accuracy, and accuracy as a source of ship's course and speed (for use with Satnav). Reception was good, even in severe precipitation static when DECCA and LORAN-C lost lock. From a limited preliminary analysis, the range accuracy of Omega, with sky wave corrections (SWCs) is around ±5 centicycles (cec) (±1.5 km) with peak errors of ±20 cec (±6 km). Two possibilities of improving SWCs will be investigated: (1) "Composite Omega" using two or more frequencies which are affected differently by changes in the ionosphere, in a manner analogous to ionospheric refraction correction in Satnav by measuring on two frequencies; (2) the use of Satnav/Omega comparisons to build up an error history of SWCs, which can then be used to forecast day by day.

A differential VLF test was arranged with Shell Canada Ltd., which operated a Global receiver in St. John's for this purpose. Unfortunately the rubidium frequency standard failed and only hyperbolic readings could be recorded.

Hyperbolic LORAN-C

Ocean Circulation was outbid in its request for Rho-Rho LORAN-C on the *Hudson's* cruise to Denmark Strait, so two Internav hyperbolic receivers to operate cross-rate on the Atlantic and Norwegian Sea chains were purchased. Programs for latticing and hyperbolic to geographic interconversion were developed. The method worked well, and was subsequently used by BIODAL for surface current measurement by ship's drift.

The Navigation Group proposed that hyperbolic LORAN-C be adopted as the coastal offshore zone navaid for eastern Canada. Error characteristics, cycle identification problems, etc., associated with the proposal, are being investigated.

Hudson's Navigation Center

After prolonged discussions with BIO Technical Services, work was started on a navigation center in *Hudson*. The plotting area immediately abaft the bridge was to be sealed off, and divided athwartships by seven electronic equipment racks, such as LORAN-C, log, and gyro, an optimising general navigation computer, etc. The layout is designed so navigation can be run by the ship's officers from the bridge side: alternatively part or all of the equipment can be operated from the afterside by BIO staff, without interfering with the Officer of the Watch.

Advice and Assistance

This covers a lot of work. Advice and assistance were given to many people, mostly in BIO, some at Dalhousie, DREA, industry, etc.

TIDAL SECTION

The Tidal Section is responsible for directing tidal, tidal current, and water levels work carried out by the Canadian Hydrographic Service in the Atlantic Region.

During the year the section was engaged in several projects, both short-term and continuing. Tide gauges have been supplied to hydrographic field parties and other users within the Institute, as well

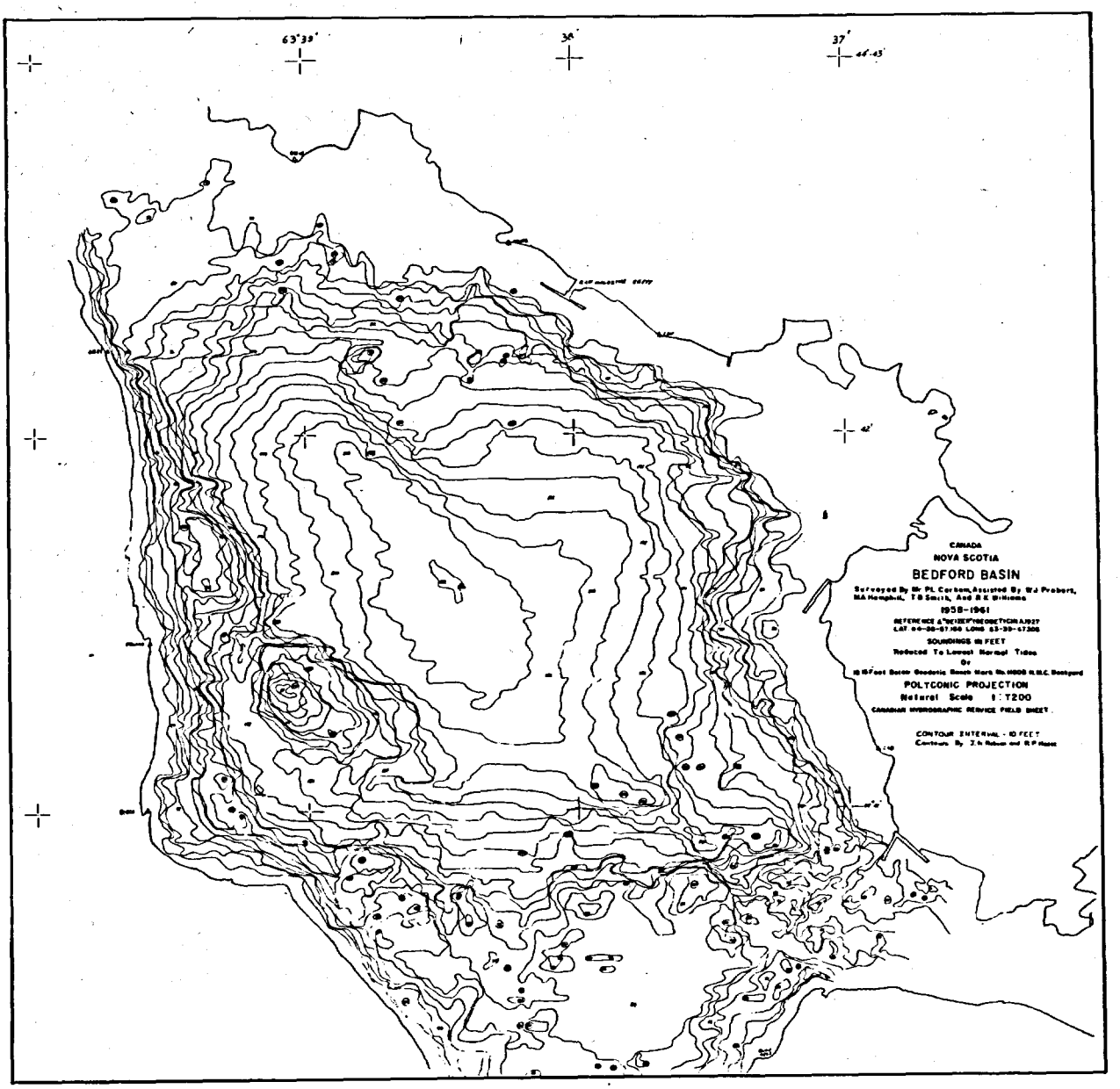


FIG. 14. Contour chart of Bedford Basin produced from conventional survey.

as Memorial and Dalhousie universities. The data obtained from these gauges are digitized and forwarded to Tides and Water Levels in Ottawa, for subsequent processing and dissemination.

The 1973 current meter program utilized H. W. Buoyant Meters which were supplied to the various field parties. Moorings were made in Sept Iles, St. Mary's Bay, Nfld., the eastern shore of Nova Scotia, and the Labrador coast. The records have not yet been analyzed, but useful information should be obtained for both the mariner and the oceanographer, with the exception of Sept Iles, where, unfortunately, no data were obtained because the meters were cut from their moorings by vessels. One meter was recovered by side scan sonar, after conventional methods of recovery failed.

The data processing capabilities of the section were steadily increased during the year. Most existing computer programs have been modified for use on the Dalhousie CDC 6600 computer, which is used via a telecommunications link in the Institute. Some programs used by Tides and Water Levels were obtained, including the flexible analysis program and the standard tide prediction program. Tidal analysis and prediction were done routinely throughout the year for various establishments in the Institute.

There have been significant advances in the data-gathering capabilities of the section, notably the Tides and Water Levels in situ tide gauge. Three bottom-mounted gauges were moored in the approaches to Halifax Harbour off Chebucto Head, in support of field trials conducted by Tides and Water Levels Section. Recovery took place in July and after testing in Ottawa, one gauge was returned for use and retention. It was loaned to Ocean Circulation and moored in Denmark Strait for about a month. Unfortunately, the mooring depth was too great, rendering the data useless. Subsequently, the instrument was moored on the Scotian Shelf in October. The data obtained from this mooring should give a better picture of the tides near the edge of the Continental Shelf, particularly as an input to the Gulf of Maine/Bay of Fundy system.

Work has been progressing favorably on the development of a telemetry system for the in situ tide gauge. The engineering and design of this system has been undertaken by the engineering services section and a working model should be ready for testing in 1974.

Various small projects were completed during the year, including a program written in FOCAL to do offshore tide reductions for the Sept Iles hydrographic survey.

COMPUTER PROGRAMS WRITTEN

Charting

Major Programs Written or Modified to Run on the HP2100: Language (Name), Function

FORTRAN IV Assembler (STCNT), transfers BIODAL paper tape to magtape, performing error checks

FORTRAN (SPTRK), plots ship's tracks on polyconic projection

FORTRAN (SERUN), checks blocked BIODAL tapes for errors

FORTRAN (SBLOK), blocks BIODAL data onto magtape

FORTRAN (SDBAT), extracts depth digitizer data from magtape

FORTRAN lambda to geographic conversion

ASSEMBLER (SWORD), packs and unpacks ASCII characters in memory

Major Programs Written or Modified to Run on the PDP-8[1]*: Language, Function*

PAL III, FOCAL, extract Hi-Fix readings from HAAPS tape, convert to geographic in format suitable for processing geophysical data

PAL III, extract bathy data from HAAPS tape and store in format for later merging with geophysical data

PAL III, transfer BIODAL paper tape to magtape

PAL III, store geophysical leader tapes on magtape

Development

FOCAL, fast UTM range–range lattice plot UTM range-range error lobe plot quadrilateral adjust

FORTRAN, *Magcomplot*, for processing BIODAL sounding data on HP2100 computer

FORTRAN, *Sortmerge*, sorts and merges data files on CDC 3100 system

FORTRAN, *HAAPSMT*, checks, formats, and merges final HAAPS data for submission to cartographic data base

[1]These programs have no name per se — they are "packages" of routines designed to perform specific tasks.

Tidal

FORTRAN IV Machine 3150, calculates the correlation between two tide gauge records in order to find the effects of chart speed on the harmonic constituents

Navigation

PDP8 Assembler, least squares Rho-Rho LORAN-C ranges to geographic position

FORTRAN IV for CDC 3100, latticing any hyperbolic navaid on transverse mercator

FORTRAN IV for HP2100 and FOCAL-8K & 4K, fast alerts (D.E. Wells' program)

FORTRAN IV for HP2100 and FOCAL-8K, DECCA readings to course and speed: Satnav fix to DECCA readings

FORTRAN IV for HP2100, Rho-Rho LORAN-C to geographic

FORTRAN IV for HP2100, DECCA Lambda to geographic

FOCAL-8K, range-range Hi-Fix calibration by hydrolist

FOCAL-8K, doppler sonar calibration by sextant fix

FOCAL-8K, main chain DECCA readings at specified graticule intersections

Binary loader compatible with PDP8 OS8 system

Dectape copying program compatible with PDP8 OS8 system

Conferences and Meetings

TWELFTH ANNUAL CANADIAN HYDROGRAPHIC CONFERENCE

The twelfth Annual Canadian Hydrographic Conference was held in Victoria, B.C., February 27–March 1, 1973, sponsored by Pacific Region, Canadian Hydrographic Service, and Canadian Hydrographers Associates.

M. Bolton officially welcomed over 160 guests and delegates from government and industry, including representatives from the UK, USSR, and the USA. Theme of the conference was Reading Between the Lines, and several papers were read by delegates from Canada and visiting countries.

Of special interest were papers on A National Grid Reference System for Canada presented by Dr S. G. Gamble, assistant Deputy Minister of the Department of Energy, Mines, and Resources, and Hydrographic Survey Methods in the Arctic by Rear Admiral V. D. Shandabylov, Deputy Chief of the Department of Navigation and Oceanography, Leningrad, USSR.

Papers were read by the following: P. O. Lee (The Increasing Role of Divers in the Pacific Region); A. D. O'Conner (Sound Velocity and Echo Sounders); J. A. Vosburgh (Side Scan Sonar — Operation Techniques for Hydrographic Application); R. F. Macnab (The Offshore Surveys Program — Review and Forecast); R. G. Burke and J. R. Robson (Evaluation of the Bo'sun Multi-Beam Sonar and its Future in Hydrography); R. M. Eaton (New Departures in Navigation); R. S. Bryant (Reading Between the Lines — Sonar Development); F. L. De Grasse and P. Brunavs (Use of Decca Lambda Over Fresh Water); A. J. Kerr (Planning and Technology of Future Hydrographic Surveys in the Arctic); S. Crowther (Ship and Shore Hydrographer); D. Ellwood (Data Bases).

INTERNATIONAL MEETINGS

Members of the Canadian Hydrographic Service participated in the following International Meetings:
Pan American Institute of History and Geography, in Panama;
North Sea International Chart Commissions in Stockholm, Sweden;
Nato – Shape Map and Chart Committee Meetings in Brussels, Belgium;
Preparatory Conference of the U.N. Seabed Committee in New York. N.Y.;
Canada/USA Reciprocal Fishing Agreement in Washington, D.C.;
Preparatory Conference of the U.N. Seabed Committee in Geneva, Switzerland;
The American Society of Photogrammetry and the American Congress on Surveying and Mapping in Washington, D.C.;
The Fourth Geodesy/Solid Earth and Ocean Physics Research (GEOP) Conference at the University of Colorado, Boulder, Col;
Buoy Technical Meeting of the Tidal Workshop at Woods Hole, Mass.;
The International Association of Seismology and Physics of the Earth's Interior in Lima, Peru;
Planning Meeting on Ship Operations in GATE and the Tropical Experimental Board for GATE Meeting in Geneva, Switzerland;
Mathematical Modelling of Estuaires at Oregon State University, Corvallis, Oreg.

PAPERS PUBLISHED

A. J. Kerr
Recent changes in Canadian Sailing Directions (International Hydrographic Review, Vol. 5);
Hydrography in Central Region

A. R. Mortimer
Motorola range positioning system when used with a low-grain omni-directional antenna (International Hydrographic Bulletin)

R. M. Eaton
A proposal for LORAN-C coverage of Atlantic Canada;
Cruise report CFAV *Sackville* 73-010

S. T. Grant
Rho-Rho LORAN-C combined with Satellite navigation for offshore surveys (International Hydrographic Review);
Bedford Institute user's guide to Rho-Rho LORAN-C

N. Stuifbergen
DECCA fixed errors in Canso Strait (Preliminary report);
Notes on the use of Doppler-Sonar with satellite navigation (preliminary report)

J. E. Hogglund
Investigation of additional secondary phase-lag at 100 kHz due to overland path (preliminary report)

D. J. Lawrence
L. A. Foster
R. H. Loucks
Studies of currents for navigation and dispersion in Canso Strait and Come-by-Chance Bay (Report series. Bedford Institute Report 73-6)

Abbreviations

ADAS	Airborne Data Acquisition System
ADS	Automatic Drawing System
AGC	Atlantic Geoscience Centre
AHS	Airborne Hydrographic System
AOL	Atlantic Oceanographic Laboratory
APC	Analytic Plotter
ATP	Airborne Terrain Profiler
BIO	Bedford Institute of Oceanography
BIODAL	Bedford Institute of Oceanography Dartmouth Atlantic Laboratory
CCIW	Canada Centre for Inland Waters
CCRS	Canada Centre for Remote Sensing
cec	centicycle
CIDA	Canadian International Development Agency
CPCGN	Canadian Committee on Geographical Names
DND	Department of National Defense
DPW	Department of Public Works
DSS	Department of Supply and Service
EBT	Electronic Bathythermograph
EMR	Department of Energy, Mines, and Resources
FIG	Federation International Geodesy
GATE	Garp Atlantic Tropical Experiment
GEBCO	General Bathymetric Charts of Oceans
HAAPS	Hydrographic Acquisition and Processing System
HYPOS	Hydrographic Processing System
IHS	International Hydrographic Society
INS	Initial Navigation System
IWD	Inland Waters Development
LSC	Lake Survey Centre
MAREP	Marine Reporting System
MCAPP	Mapping, Charting, Aerial Photography
MRS	Mine-Ranger System
MSD	Marine Service Division
Navaid	Navigational Aid
NRC	National Research Council
OICC	Ontario Institute of Chartered Cartographers
R&D	Research and Development
Rho-Rho	Range-Range
RPS	Range Positioning System
Satnav	Satellite Navigation
SDT	Salinity-Density-Temperature
SWC	Sky Wave Corrections
VLF	Very Low Frequency