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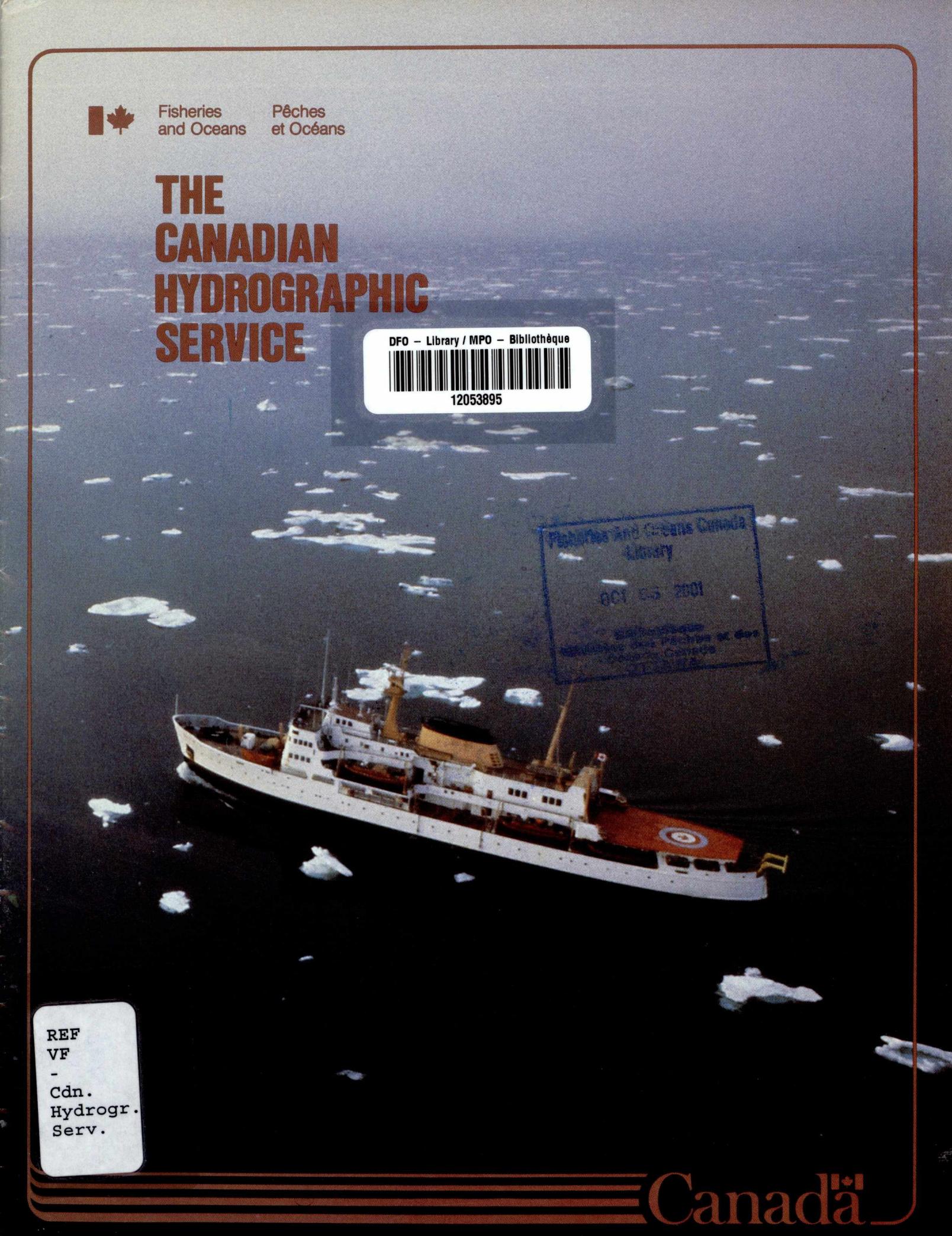


Canada

THE CANADIAN HYDROGRAPHIC SERVICE

In the continuing search for natural resources in Canada's remote offshore areas, the men and women of the Canadian Hydrographic Service (CHS) play an essential but generally unheralded role.

The summer of 1981 saw hydrographers aboard one of Canada's major hydrographic and oceanographic research vessels, HUDSON, survey half of a relatively narrow corridor through an area of the western Arctic's Beaufort Sea, where underwater pillar-like hills rise randomly and menacingly near the surface.

Hydrographers aboard another vessel, BAFFIN, surveyed a constricted, danger-filled strip of water in the eastern Arctic — Fury and Hecla Strait — part of a proposed shipping route. These are only two of the many surveys included in the hydrographic service's navigational survey and charting program. If oil and gas are ever to be transported safely out of the resource-rich Arctic, accurate navigational charts are a prerequisite.

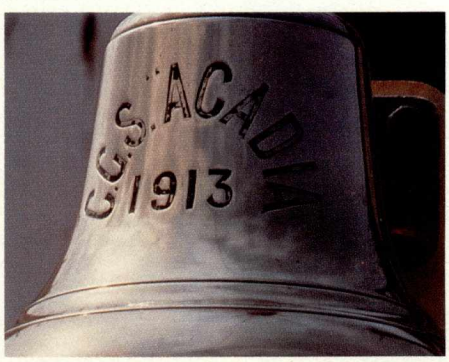
Marine charts are important not only in the development of offshore natural resources. Commercial ships moved about 320 million tonnes of cargo to and from Canadian ports in 1981 using CHS charts. Charts are essential to the domestic and foreign fishing fleets operating off Canada's east and west coasts. Charts are also in increasing demand by the hundreds of thousands of pleasure boaters crowding Canada's waterways.

HISTORY OF CANADIAN HYDROGRAPHY

The earliest sailing directions were compiled with the help of experienced sea captains. Among the earliest contributors to Canadian hydrography were the explorers Cabot, Cartier and Champlain.

The first hydrographic surveys in Canada were carried out by the Spanish, French and the British Navies. Admiral Henry Wolsey Bayfield conducted many of the original surveys of the Great Lakes and the Gulf and River St. Lawrence, as well as surveys of the Atlantic coast. His charts were the foundation on which most subsequent hydrographic surveys were based. In honour of his contribution to Canadian chart-making, the CHS traditionally names one of its vessels "Bayfield".

The Great Lakes Survey was established in 1883 and in 1904, the Canadian Hydrographic Service was created. By 1911, Canada had assumed complete control of its hydrographic survey operations except for surveys of the Newfoundland and Labrador coasts which became a Canadian responsibility when Newfoundland joined Confederation in 1949.



STRUCTURE AND ACTIVITIES OF THE CHS

Today, the Canadian Hydrographic Service is part of the federal Department of Fisheries and Oceans. It uses a fleet of about 180 vessels ranging from oceangoing, multi-purpose research ships to small launches.

The CHS is responsible for charting Canada's 131,650 nautical miles of coastline (the longest of any country in the world) and 739,266 square nautical miles of continental shelf and territorial waters.

Hydrographic surveys are conducted from the northern tip of the Canadian Arctic to inland recreational waters. The CHS has also sent its ships to such distant areas as the Caribbean Sea and the coast of West Africa to carry out surveys for developing nations.

The headquarters of the CHS is in Ottawa, with field operations carried out by four regional groups, each having its own area of responsibility.

Regional Operations

The Atlantic Region is based at the Bedford Institute of Oceanography at Dartmouth, Nova Scotia. From Dartmouth, ships fan out each spring on their survey cruises covering most of the Gulf of St. Lawrence, coastal and offshore waters of the Atlantic provinces, Labrador and the eastern Arctic.

The Central Region, with headquarters at the Canada Centre for Inland Waters in Burlington, Ontario, covers the nation's busiest marine traffic area — the Great Lakes and the St. Lawrence Seaway, as well as other smaller lakes and waterways in Ontario and Manitoba. Many of the surveys of this area are carried out from launches. In addition to these southern areas, Central Region is also responsible for surveys of Hudson and James Bay, where the work ranges from shore-based local surveys to offshore and through-the-ice winter surveys.

The Pacific Region of the CHS is located at the Institute of Ocean Sciences at Patricia Bay near Sidney, B.C. Opened in 1977, this institute, like the Bedford Institute, houses the CHS as well as other government agencies. Their surveys cover B.C.'s inland lakes, coastal and offshore areas, the Athabasca-Mackenzie waterway, and the western Arctic.

The Quebec Region was established in 1976 with offices at Quebec City. Its area of responsibility covers the northern part of the Gulf of St. Lawrence and the St. Lawrence River to the Ontario-Quebec border.

In all its survey and charting activities, the CHS is cognizant of its membership in the small, highly specialized worldwide fraternity of hydrographic surveyors. Regardless of nationality, hydrographers are constantly aware that they are trying to serve the needs of all mariners. There is close liaison and cooperation between nations, fostered by the International Hydrographic Organization (IHO), headquartered in Monaco. The IHO strives to achieve uniform standards of excellence, and standardization of surveys and charting to aid international marine traffic. As an active member of the IHO, the CHS operates according to those standards in survey and charting programs.

New Technology

The CHS continually employs new technology to increase the speed, efficiency and accuracy of its operations.

In addition to efforts to improve the automation of chart production, new electronic positioning and navigation systems are continually being developed and refined. Faced with the magnitude of the charting task in the Arctic, the CHS is working to develop new ways of adapting the traditional echo sounder and tide gauge for through-the-ice surveys.

At the same time, research is being carried out on totally new methods of sounding such as aerial hydrography for inshore surveys and the use of side scan sonar and multiple beam echo sounders to provide total bottom coverage for deep-draught navigation.

THE HYDROGRAPHIC SURVEY

Sounding

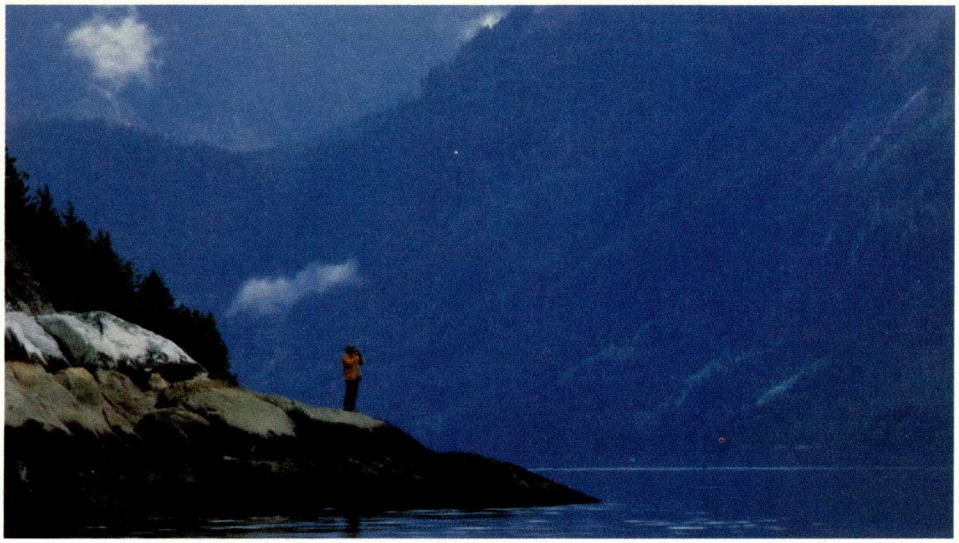
The most common and fundamental operation in hydrographic surveying is sounding, that is, measuring water depths.

For centuries, and still within the memory of older Canadian hydrographers, soundings were obtained simply by lowering a lead weight on a wire. This method, while accurate, is extremely time-consuming and does not give a continuous "profile" of the bottom. The leadline is still used at times to confirm depths measured by echo sounders. An echo sounder, in a moving vessel, sends a series of sound signals to the bottom which are reflected to a receiver in the vessel.

The sounding vessel examines the survey area systematically; the spacing between sounding lines determined by the scale of the survey. In some hazardous areas it is desirable to have total bottom coverage.

Normally, the electronic device which emits the sound signal — known as a transducer — is located in the hull of the survey vessel. In the Arctic, however, hydrographers have had to develop new methods of sounding in order to survey ice-covered waters.

These through-the-ice soundings are frequently carried out by helicopters or tracked vehicles



equipped with echo sounding systems capable of sending and receiving signals through the ice.

Positioning

Soundings must be located precisely on a chart in relation to the coast. The hydrographer, therefore, must always keep track of his own position. In earlier days, when surveys were usually conducted within sight of shore, this was done exclusively with the aid of the sextant, an instrument for measuring angles.

Although the sextant remains an important instrument, several types of radio positioning systems allowing the hydrographer to work out of sight of land or in poor visibility have been introduced. While these electronic systems are complex, they are simple to operate. Their main features are transmitters and receivers equipped with counters, like the odometer in a car, from which the position of the ship can be read at a glance.

Tides

The soundings shown on a field sheet or chart must be described in terms of depth. This requires the determination of a water level. This level, referred to as the chart datum, is the level below which the water surface will seldom fall. Knowledge of water levels is necessary for the accurate compilation of charts and is used in coastal engineering studies, resource planning and to formulate future tidal predictions. Permanent water level gauges are maintained along Canada's coast and major inland waterways to provide a continuing record of water levels.

The CHS also maintains two telemetering gauges along the west coast which are a vital part of the Tsunami Warning System. This is an international automatic system which provides alerts about these large and sometimes devastating waves caused by earthquakes or eruptions beneath the seas.

Currents

Knowledge of currents — the horizontal movement of the water — can be vital to safe navigation. Where required, hydrographic survey parties collect data on current speed and direction.

The usual method of obtaining this data is to suspend on a single line several instruments which automatically record on magnetic tape the speed and direction of currents at specific depths. The line is anchored to the seabed and supported by an underwater buoy.

Instruments are retrieved after recording for a desired period, usually at least 29 days, to complete a full tidal cycle.

Other Information Collected by Hydrographers

A hydrographic field party also collects samples of the sea floor at regular intervals. This information is of interest to mariners, fishermen, construction engineers and researchers.

Hydrographic surveyors also check the positions of all fixed and floating aids to navigation. The position of conspicuous natural or man-made landmarks is recorded as well.

To meet the needs of offshore resource development, such as seabed mining and drilling for oil and gas, the scope of the hydrographic survey has broadened to include the data required in the search for offshore resources.

THE HYDROGRAPHIC SURVEYOR

The field of hydrographic surveying is a specialization of growing complexity and importance. Hydrographic surveyors must possess a good background in mathematics and general survey techniques. Recruits entering the survey element of CHS come from technological institutes for surveyors, or are university graduates in civil or survey engineering, or mathematics.

Due to the nature of hydrographic surveys and the fact that no Canadian university offers a specialized course in hydrography, the CHS provides a four-month training program for all new survey personnel as well as advanced courses for experienced hydrographers.

The CHS has been an active participant in the IHO/FIG (Fédération Internationale des Géomètres) International Board on the Training of Hydrographers. Employees of private survey companies and hydrographic offices of developing countries have taken CHS courses.

SHIPS

Canadian Hydrographic Service ships are specially outfitted for surveying. They possess facilities for handling equipment such as survey launches, current meters, bottom-sampling and geophysical instruments.

The largest survey-equipped ship, the 3,400-tonne Baffin, operates from the Bedford Institute of Oceanography. She is equipped with five launches, landing and hangar facilities for two helicopters, three echo sounders, Decca and Loran position-finding equipment, a satellite navigation system and various other aids to navigation and communications. Baffin was designed to withstand the rugged Arctic conditions and has been used extensively for surveying in the north.

The survey-research fleet also includes a number of smaller vessels and launches. In addition to the CHS fleet, other Fisheries and Oceans research vessels conduct hydrographic surveys. Also, ships of the departments of National Defense and Transport often permit hydrographic work to be carried out during their northern cruises.

SURVEY AND CHART PLANNING

Most survey requirements now arise from the need for more large scale charts. Many older charts were compiled on the principle that ten metres was the minimum safe depth along sea coasts, and six metres the safe depth for the Great Lakes. Today's supertankers draw over thirty metres, and the large lake carriers more than eight metres, so many shipping lanes and harbours must be resurveyed. For those areas of water that just meet these new critical depth requirements, much more detail is required.

Survey requirements are also affected by fluctuating economic conditions which create new resource exploration and development sites.

The growing number of recreational boaters has created a large demand for charts of many unsurveyed small craft routes and harbours of both coastal and inland waters.

There is also a continuing need for revisory surveys to update chart information for the positioning of navigational aids (fixed and floating); to check the location of reported shoals and wrecks; to survey around changes in dock facilities; and resurvey dredged areas. Chart planning in border waters is coordinated by the United States-Canada Hydrographic Commission.

CHART PRODUCTION

Once a survey has been completed, a plastic field sheet, containing the soundings and other data, is sent to cartographic units at either Ottawa or one of the regional offices.

In the chart compilation process, the field sheets and other topographical and shoreline data are photographically reduced to chart scale.

A format is then chosen to display selected data emphasizing the critical shoals or other hazards to navigation; to provide general bathymetric coverage; and to present to the mariner a document which can be used to plan and plot a vessel's course.

Following the compilation stage, the graphic data is converted into a computer-compatible form for automatic drawing by a computer-controlled plotter. The plotter draws the lines, numbers and symbols precisely, producing high quality negatives for the printing process.

Marine Cartographers

Cartographers joining the CHS today are usually graduates of cartography courses offered by technical institutes. Since none of these institutes offers a specialized course in marine cartography, the CHS operates a training program in Ottawa to teach the specialized skills required and further the knowledge of experienced cartographers.

PUBLICATIONS

The CHS publishes some 1,500 nautical charts and 80 per cent of the 500,000 charts distributed each year are sold through authorized chart dealers, in Canada, the U.S. and overseas.

New information is constantly received from other federal and provincial agencies, commercial users, and pleasure craft operators. In addition, field units in each region conduct annual revisory surveys of charted areas to update the information on the charts.

Charts are also continuously up-dated from Notices to Mariners, which are issued jointly by the CHS and Transport Canada and published weekly. These notices show the latest changes in position and characteristics of buoys, lights, radio beacons and similar aids to navigation, or newly discovered dangers to navigation. Mariners are required by law to have on board the most recent editions of charts and to keep them updated from Notices to Mariners or from radio navigational warnings.

Sailing Directions and Small Craft Guides

Sailing Directions and Small Craft Guides supplement the information on charts. Sailing Directions are books containing detailed information needed for safe navigation and are intended to be used in conjunction with charts.

Most editions of these publications contain numerous aerial photographs of the main harbours, anchorages and passages covered by the volume. They also include tables of distances, climatic variations, and wharves and sheds for the main harbours.

Between new editions published at two-to-four-year intervals, Sailing Directions are updated through the weekly Notices to Mariners.

Tide and Current Tables

The CHS issues annual Tide and Current Tables, for Canadian waters exhibiting significant tidal fluctuations. The tide tables provide predicted times and heights of high and low waters, and enable the mariner to compute the height of the tide at any time of any day of the year. This information is used in conjunction with the depth information shown on the chart.

The current tables contain the times of slack water and the times and rates of maximum flow for each day of the year for regions in which this information can assist safe navigation. Current information may also be presented through symbols on the charts, descriptions in Sailing Directions, or diagrams in atlases.

Geoscience Mapping

The CHS also produces natural resource maps (NRM) which depict the ocean floor adjacent to Canada.

These maps, at a scale of 1:250,000, are a seaward extension of the National Topographic System (land maps). These are used to help identify areas of geological and geophysical significance in the search for new resources. A second series of Natural Resource Maps, at 1:1,000,000, is also available for certain areas.

The CHS is also publishing the Fifth Edition of the General Bathymetric Chart of the Oceans (GEBCO), a world-wide series coordinated jointly by the International Hydrographic Organization and International Oceanographic Commission of UNESCO, at a scale of 1:10,000,000 at the equator. Within Canadian areas, bathymetric data from industry, other federal agencies, and foreign services are available to the public on plotting sheets at a scale of 1:1,000,000.

Special purpose maps of particular geological and other phenomena are also produced together with descriptive texts in the Marine Science Paper series.

It is a crucial challenge to probe the undiscovered secrets of the ocean depths — the last great frontier remaining on earth — and the Canadian Hydrogrphic Service is playing a vital role in meeting that challenge.

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