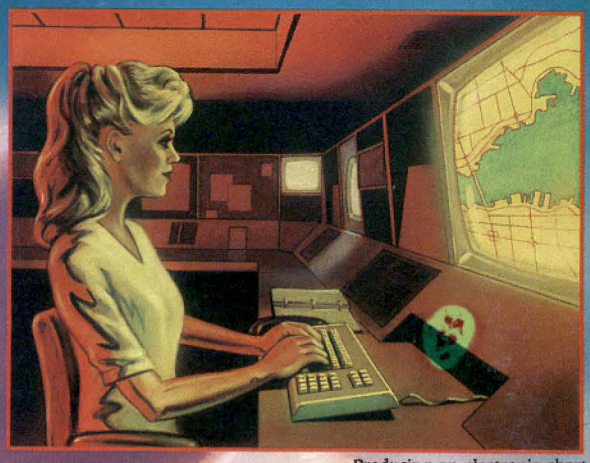
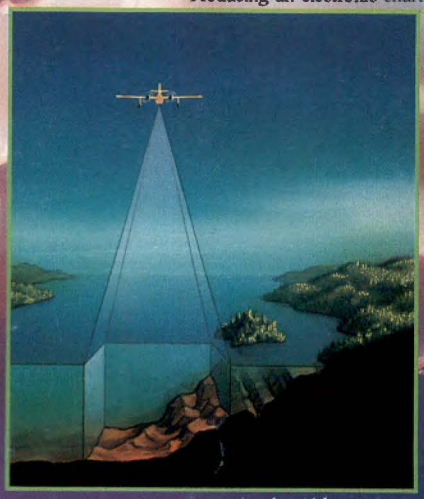
Charting the Future

Scientific Excellence in Canada's Waters



Producing an electronic chart



Surveying by Airborne Laser

Hydrography

Surveying by remotely controlled vehicle

Fisheries and Oceans Pêches et Océans

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Charting the Future

Hydrography

Science Sector
Department of Fisheries and Oceans

This is one of a series of brochures describing the Department of Fisheries and Oceans' Science Program.

The others are:

Exploring the Underwater World (Science Sector)
Understanding the Living Resources (Biology)
Discovering the Ocean's Secrets (Physical and Chemical Sciences)

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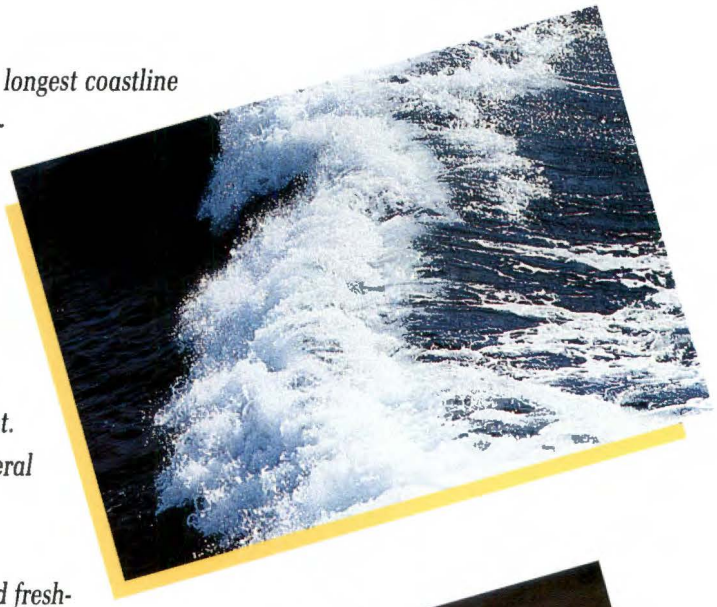
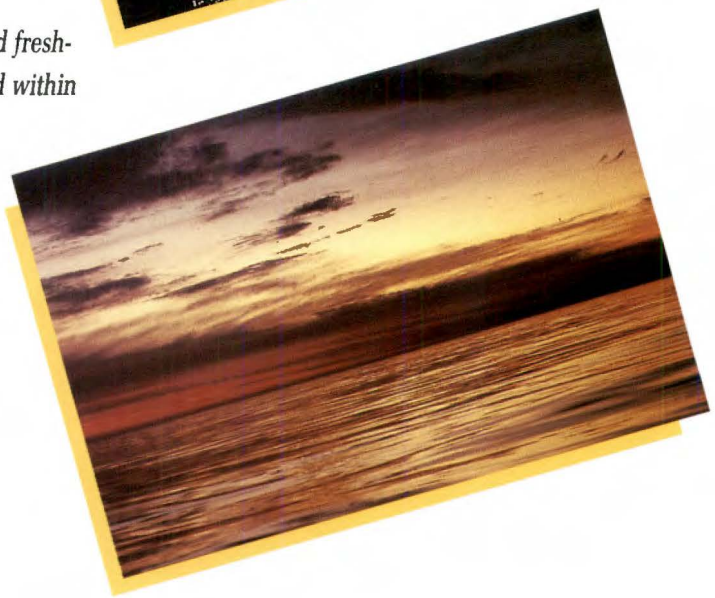
Canada and the Oceans



Canada is a maritime nation. This is the country with the longest coastline in the world, the longest inland waterway, the largest archipelago, part of the world's largest freshwater system, some of the richest fishing grounds and some of the largest untapped offshore oil and natural gas reserves.

We must build our understanding of our oceans, waterways and aquatic resources — a formidable scientific challenge that rests primarily with Canada's federal government. The Department of Fisheries and Oceans (DFO) is the federal department responsible for much of this research effort.

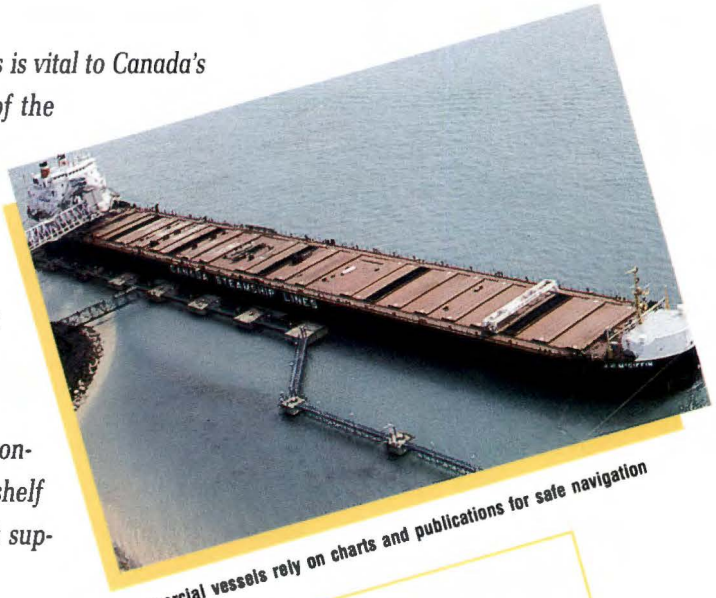


Encompassing both the fisheries and the oceans, marine and freshwater environments, DFO's scientific expertise is consolidated within one organization known as the Science Sector.

The Sector covers three main areas: Biological Science, Physical and Chemical Sciences and Hydrography. This brochure provides an overview of the Hydrography component of the Science program.

Charting the Future

The ability to navigate surely and safely in Canadian waters is vital to Canada's well-being. Water-borne trade is the economic lifeblood of the nation. Commercial ships carry more than 350 million tonnes of cargo to and from Canadian ports each year and more shipping passes through the St. Lawrence Seaway than through the Panama and Suez canals combined. Canada has the longest coastline in the world and the Great Lakes are one of the world's largest freshwater systems.



Commercial vessels rely on charts and publications for safe navigation

Canada also has almost 740,000 square nautical miles of continental shelf — the seabed extension of the country. The shelf contains rich oil and gas resources and the waters above it support some of the world's most abundant fishing grounds.

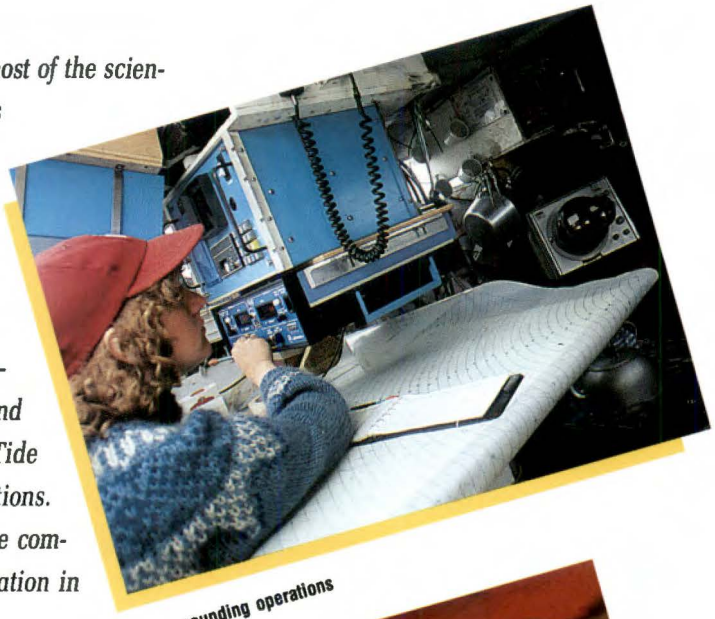
Without nautical charts, marine navigation would be slow and perilous. Without magnetic, gravity and other specialized maps, efficient development of offshore resources would be impeded.

The continental shelf

The Canadian Hydrographic Service: A Nationwide Mission

Canada's federal government is responsible for mounting most of the scientific effort needed to build our understanding of the oceans and freshwater. Part of that effort involves the charting of Canadian waters. This scientific and surveying effort is conducted by the Department of Fisheries and Oceans.

The hydrographic part of the Science Sector's mandate is carried out by the Canadian Hydrographic Service. CHS programs include bathymetric and tide and current surveys and the preparation and distribution of navigational charts, Tide and Current Tables, Sailing Directions and related publications. These activities are designed to meet the needs of the marine community and to promote safe and efficient marine transportation in Canadian and adjacent international waters.



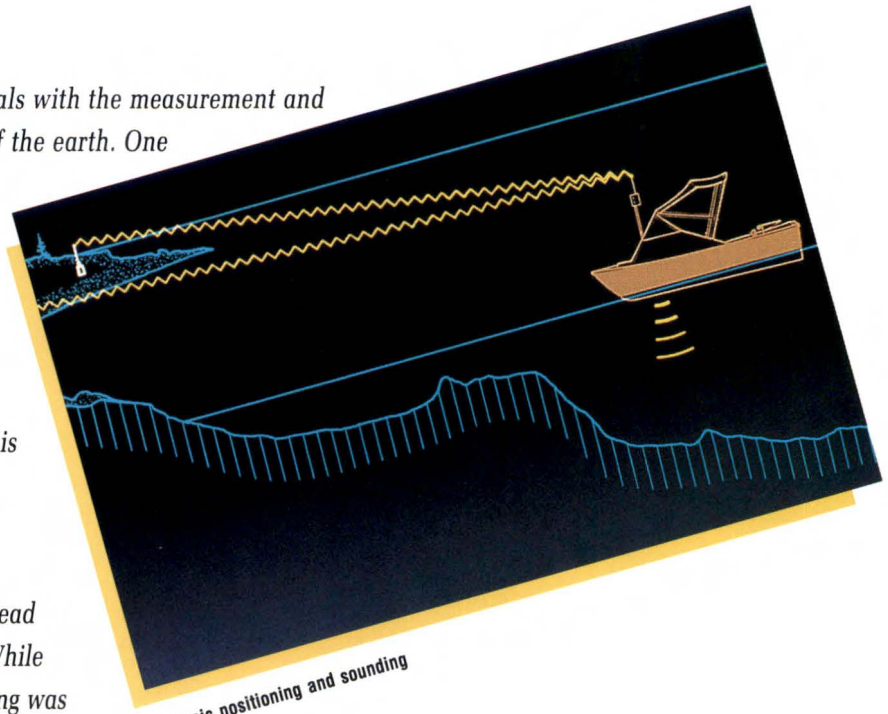
Launch sounding operations

The Department's hydrographic effort is headquartered in Ottawa with survey and cartographic operations carried out from four major centres: the Bedford Institute of Oceanography, in Dartmouth, Nova Scotia; the recently completed Maurice Lamontagne Institute in Mont Joli, Quebec; the Bayfield Institute in Burlington, Ontario; and, the Institute of Ocean Sciences in Sidney, British Columbia. A hydrographic unit is also located in St. John's, Newfoundland, at the Northwest Atlantic Fisheries Centre.

Cartography — manual scribing

Methodology

Hydrography is a science — one that deals with the measurement and description of the waters on the surface of the earth. One arm of that science is called surveying and it includes the age-old art of collecting and collating soundings and other data which are used to make charts and other aids used by seafarers.



Electronic positioning and sounding

The most basic operation of hydrography is the taking of soundings (that is, measuring water depths).

The old way of surveying was to lower a lead weight, attached to a line, into the water. While accurate enough in shallow waters, lead-lining was a slow method and it did not provide continuous, gap-free coverage of the bottom. The leadline has given way to the echo-sounder which measures depths by bouncing sound waves off the bottom. By measuring the length of time it takes for the echo to return, hydrographers calculate the distance to the bottom.

Surveys done this way follow pre-planned lines along which the surveying vessel steers. How closely the lines are spaced depends on the complexity of the seabed. In hazardous waters, complete coverage of the bottom is required.

To indicate depths at their right locations on charts, hydrographers must know exactly where the vessel is when each sounding is made. In the past, the main tool for determining the vessel's position was the sextant and, while it is still used occasionally, the main tools are now electronic positioning systems.

Tides and other changes in water level must be taken into account by hydrographers. CHS has installed permanent water-level gauges along Canada's coasts and larger inland waterways to monitor tidal- and water-level data.

Two CHS gauges on the west coast are part of an international warning system for tsunamis — dangerous waves triggered by earthquakes or seabed eruptions.

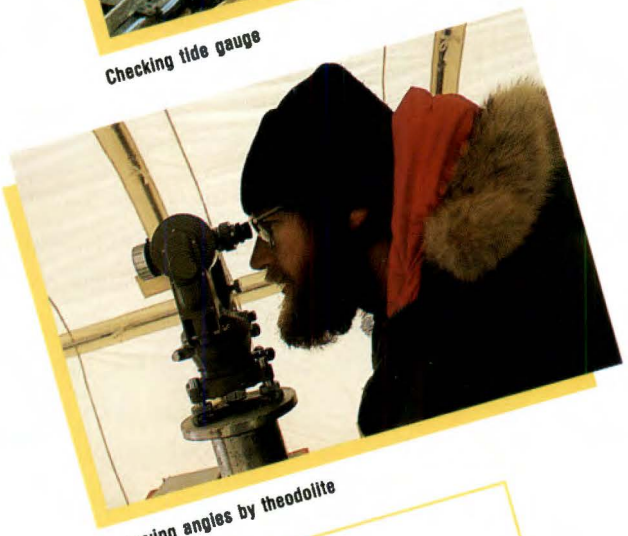
To produce accurate charts, hydrographers also need information about currents. These data are usually collected by instruments suspended in the water which record on magnetic tape the speed and direction of water flow at different depths.

Hydrographic surveyors also obtain the positions of all buoys, lighthouses and other fixed or floating navigational aids as well as the positions of landmarks, natural or man-made, which mariners use as reference points.

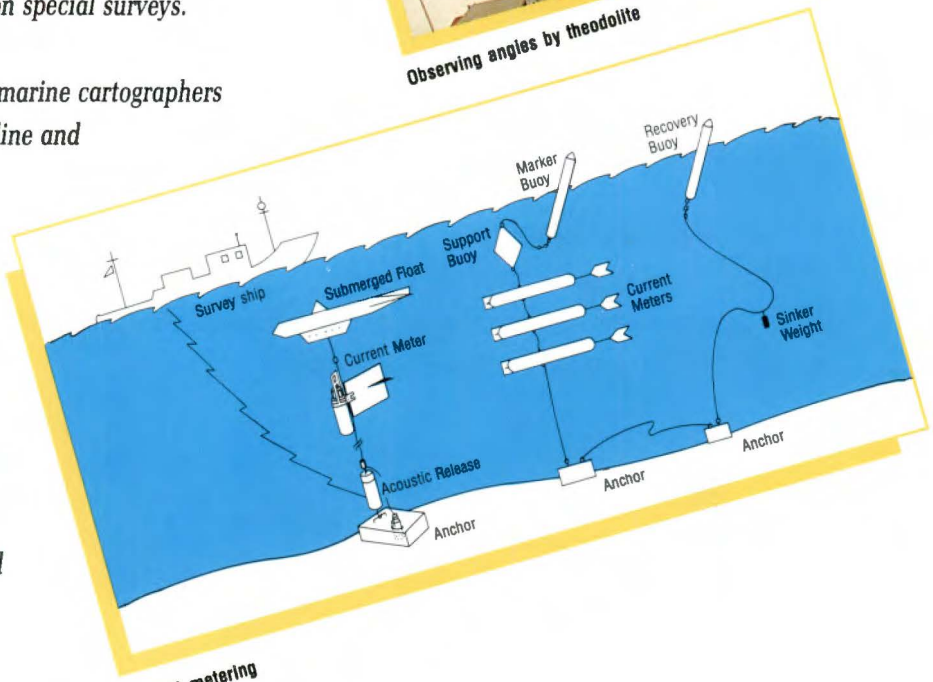
To support development of oil, gas and other offshore resources, CHS works with the Geological Survey of Canada of the Department of Energy, Mines and Resources on special surveys.

When the survey work is completed, marine cartographers combine the measurements with shoreline and other topographical data and change them photographically to the required chart scale. From this mass of material, the information most critical to safe navigation is selected and enhanced. Tide and current tables are added along with notes and geographical names. Electronic lattices (positioning lines related to radio systems) are calculated and added.

Checking tide gauge



Observing angles by theodolite



Current metering

Finally, all of this material is computer-drawn and negatives are made for the printing press for production of the final result: a modern, printed chart.

Hydrographers are now gearing up for a new step forward — the compilation of charts using data collected and stored in digital form.

Hydrography and Cartography: The People and the Training

In terms of preparatory training and background, hydrography and cartography are unique professions.

Some recruits joining CHS as surveyors come from technical institutes; others are university graduates in survey engineering or mathematics.

Cartographers are also usually graduates of technical institutes which offer courses in cartography, although some are university graduates in cartography, geography or computer science.

Since little academic training is available in nautical charting for either hydrographers or cartographers, CHS operates its own complete training programs. Covering both basic and advanced study, the courses are recognized and accredited by international bodies. The CHS programs attract students from abroad as well as employees of private surveying companies.

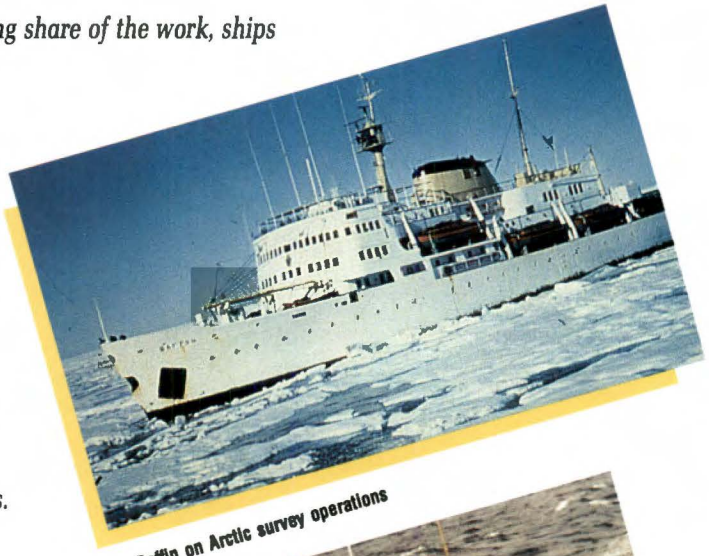
Cartographic training

Survey training

Survey Platforms

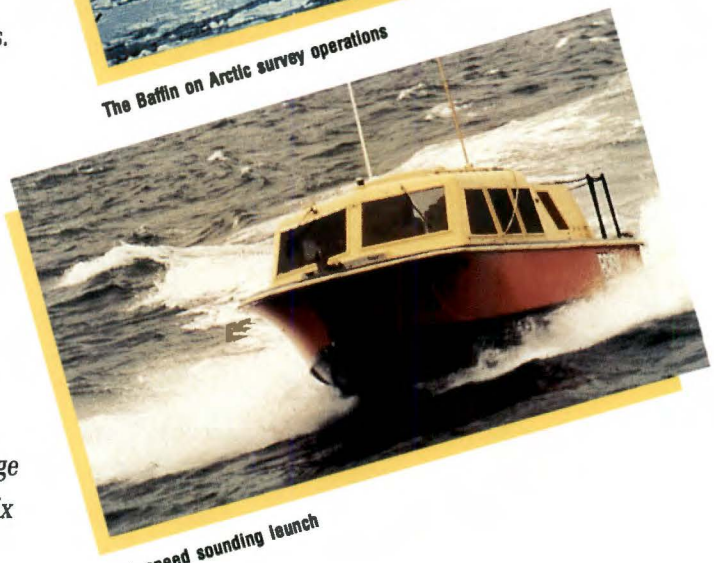
Although aircraft and satellites are taking on an increasing share of the work, ships and boats are still the main platforms for surveying.

A large part of DFO's fleet of about 180 vessels is used for hydrography. This fleet, which operates from five regional establishments, includes large and medium-sized ships for coastal and offshore surveys and smaller vessels for inshore work. Assignments cover the entire country, from the Pacific to the Atlantic and from the Arctic to the Great Lakes and St. Lawrence River. The CHS also participates in cooperative projects with other countries and carries out survey missions for developing nations.



The Baffin on Arctic survey operations

Ships used for hydrography are outfitted specifically for surveying — they carry launches and their equipment includes positioning systems, echo-sounders and bottom-sampling and geophysical instruments. The largest ship, the 3,400-tonne BAFFIN operates out of the Bedford Institute of Oceanography at Dartmouth, Nova Scotia. Designed to work in the Arctic, it is equipped with landing and hangar facilities for two helicopters. Its equipment includes echo sounders, short- and medium-range position-finding equipment, a satellite navigation system, six launches and other navigation and communication aids.



High-speed sounding launch

Changing Charts for a Changing World

The hydrographer's work is never done. As ships with deeper draughts move into previously untravelled waters, channels for their passage must be surveyed in greater detail. Meanwhile, seabed and coastal changes, shifts in shoals, dredging, new wrecks and other obstacles make resurveying a never-ending operation.

Keeping Canada on the Leading Edge

Recognized internationally as one of the world's most advanced hydrographic organizations, DFO is leading the way in the development of new tools and techniques. This development serves two purposes.

The first is to improve the efficiency with which the Department does its work. The second — through the transfer of technology to the private sector — is to foster the growth of Canadian industry specializing in this field.

DFO's achievements in this field include the development of air-based survey technology such as the laser-utilizing LIDAR system, remotely operated vehicles and semi-submersibles such as DOLPHIN and advanced application of state-of-the-art satellite-based navigation systems such as GPS-NAVSTAR.

GPS-NAVSTAR

The exciting new world of electronic charting

One of the most exciting new contributions is the development of the "electronic chart" — a system which will some day allow mariners to navigate from a videoscreen array combining a digital chart with a radar display of shipping, navigational aids, coastline and other features.

Electronic chart

By the year 2000, ships will also probably be equipped to receive hydrographic and other data from shore stations at high-speed rates. Mariners (who by then will probably be using electronic charts as a matter of routine) will be able to update charts, verify Notices to Mariners and check their own digital data bases against those held in the regional office. DFO is a world leader in the development of the digital data base which will make electronic charting possible.

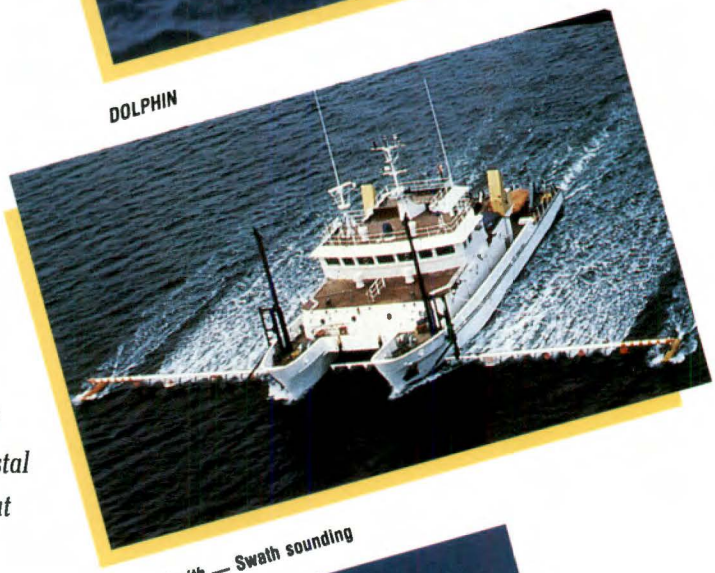
DOLPHIN: Radio-controlled survey probe

Developed by CHS in cooperation with Canadian industry, the DOLPHIN is a radio-controlled semi-submersible vehicle used for surveying water depths.

DOLPHIN

F.C.G. SMITH: High-tech catamaran

The conventional way to survey shallow waters is to take soundings along separate lines, a pass at a time. This catamaran, one of the latest additions to the departmental fleet, speeds up the process. Equipped with electronic surveying equipment developed by CHS, the vessel covers a 30-metre swath on a single pass, and without the gaps inherent in earlier systems.



F.C.G. Smith — Swath sounding

THE LARSEN LIDAR: Lasers win the race against winter

Surveying in the Arctic is a race against winter freeze-up. To make the most of the short summer, CHS has developed an airborne laser system which measures the depth of coastal waters five times faster than conventional systems — and at one tenth the cost.

LARSEN LIDAR

For the Wheelhouse

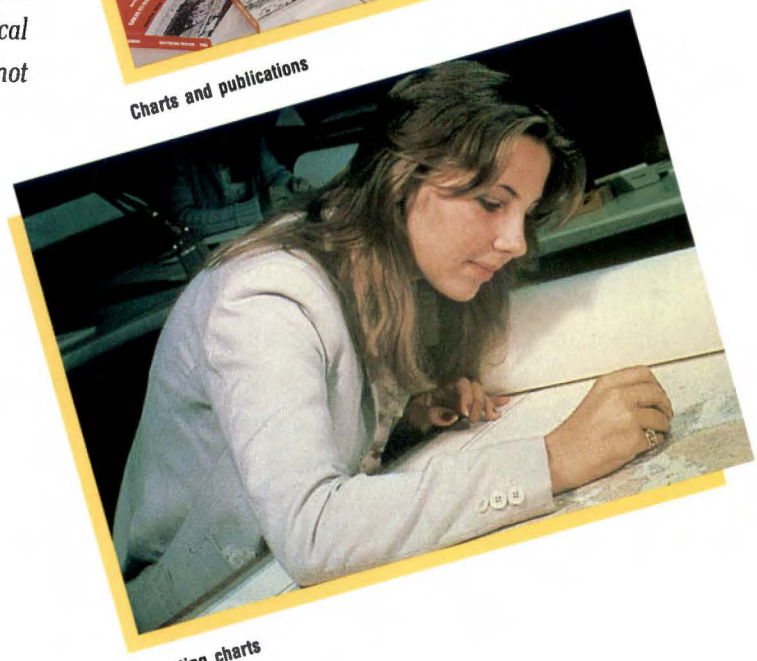
DFO publishes and maintains about 1,100 nautical charts. Some half million copies are distributed each year through authorized chart dealers in Canada, the U.S. and overseas.

Charts are also continually updated in accordance with Notices to Mariners. These bulletins are issued weekly by CHS and the Canadian Coast Guard and contain updated information on such features as buoys, lights, radio beacons or newly discovered dangers to navigation.

***Sailing Directions and Small Craft Guides** are books that supplement the information contained on charts. Physical features, ice conditions and other information that cannot be depicted on a chart are covered here.*

***Tide and Current Tables** are issued annually by DFO for Canadian tidal waters. Used in combination with charts, the tables give predicted times and heights of high and low tide. Using them, a mariner can compute the height of the tide for any given hour of any day of the year. The current tables show the times of slack water and the times and rates of maximum flow for each day of the year for selected regions.*

Charts and publications

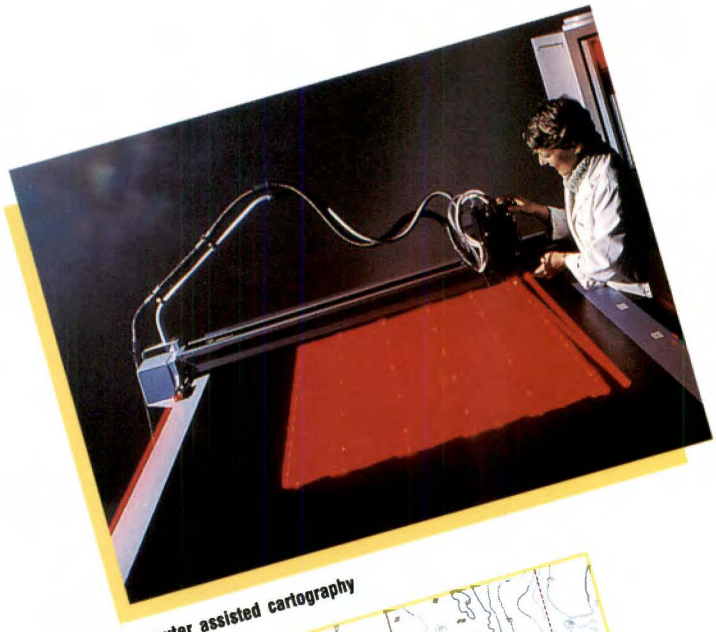


Correcting charts

Ocean Mapping

Working with the Geological Survey of Canada of the Department of Energy, Mines and Resources, DFO produces specialized natural resource maps which depict the ocean floor off Canada's coasts.

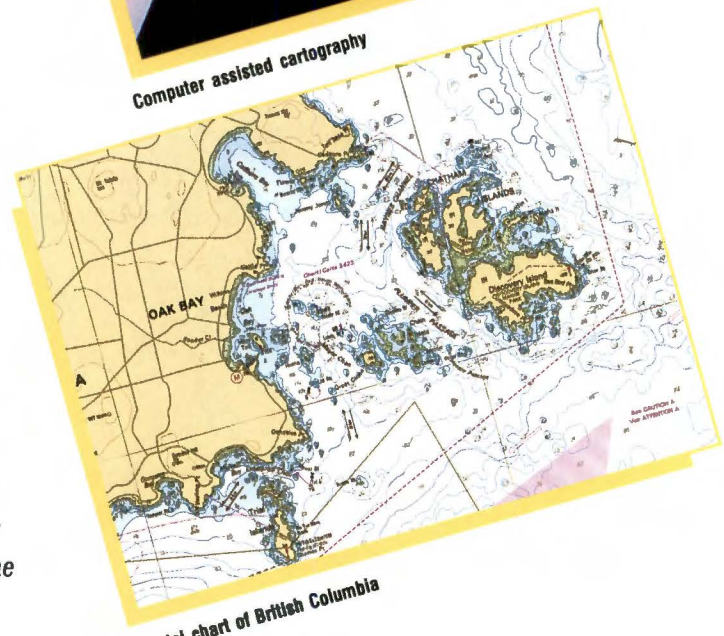
These maps are used by geo-scientists and developers of offshore oil and minerals to identify promising prospecting areas. CHS also publishes the General Bathymetric Chart of the Oceans (GEBCO), a world-wide series coordinated jointly by International Hydrographic Organization and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization.



Computer assisted cartography

The Future

Canada is a maritime nation and a country that lives by trade that travels by water. We need to learn more about the waters — how to live with our three oceans and our inland waterways, how to use them safely, how to protect them from pollution, how to navigate their surfaces, and how to exploit their resources wisely. As the world's population grows and society becomes more industrialized, demands on the aquatic environment increase, the stakes are more costly and guess work becomes more dangerous.



Coastal chart of British Columbia

The Department of Fisheries and Oceans is at the forefront of scientific effort aimed at understanding Canada's ocean and freshwater ecosystems. Through the surveying and charting of Canada's waters and the development of new technology to assist in this task, DFO is on the leading edge of charting for the future.

The Official Mandate

The overall objective of Fisheries and Oceans Science is: to ensure that scientific information of the highest international standard is available to the Government of Canada for use in developing policies, regulations and legislation regarding the oceans and aquatic life, and to other government departments, private industry and the public for use in planning and carrying out aquatic activities.

The objectives of the Hydrography component of the Science program are:

— *To collect, publish and distribute hydrographic information in the form of navigational charts, ocean maps, sailing directions, tide and current tables and related publications of Canada's offshore, coastal and inland waters in order to assist safe navigation for all marine traffic, to facilitate fishing activities and to assist coastal and offshore development and other activities and interests, and in particular:*

- *to conduct hydrographic surveys to determine the precise configuration and nature of the seabed and its geographic relationship to the adjoining landmass; and*
- *to gather information on tides, water levels and currents to describe the dynamic characteristics of Canadian waters important to navigation.*

— *To publish jointly with the Department of Energy, Mines and Resources, maps in the Natural Earth Science Series displaying bathymetry, sediment thickness, surficial geology, as well as magnetic and gravimetric fields in the Canadian offshores.*

— *To provide professional advice and services.*

— *To develop and refine the methodology and technology needed to carry out the hydrographic program.*