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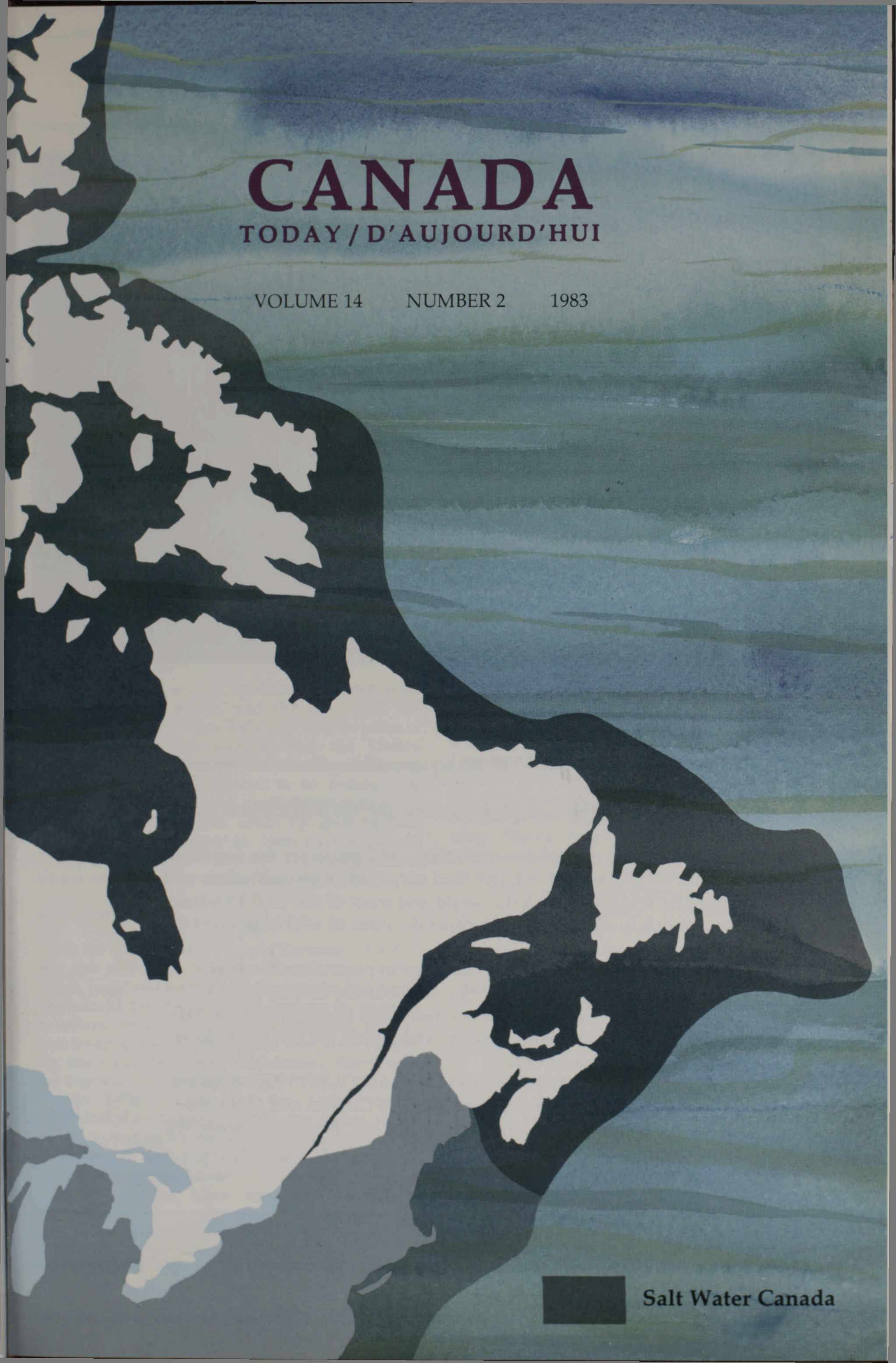


Salt Water Canada

PHOTO: NFB PHOTOTHÈQUE

Salt Water Canada

The lighthouse at Cape Spear, Newfoundland, the easternmost point in North America.

Forty per cent of Canada—739,266 square miles—is covered by salt water.

This includes three off-shore oceanic shelves and the floor of Hudson Bay.

These submerged plains and valleys and peaks are the source of food and wealth as well as havoc and surprises. They hold some of the greatest fishing grounds in the world and most of the world's whales. They are rich in oil and gas and minerals, most of which have yet to be discovered.

The bottom of Hudson Bay has been in place since the first continents were formed. The Pacific and Atlantic shelves are, in geological terms, very new. The western shelf (along with Vancouver Island and the Rocky Mountains) arrived within the last 225 million years, a relative wink in time.

In this issue of CANADA TODAY/D'AUJOURD'HUI we take a look at a part of Canada as large as Quebec, Ontario and Manitoba combined—the part that's under salt water and the one we know the least about.

Cover Photo:

This map shows the considerable part of Canada that is below the sea. The continental shelf and the slope beyond contain vast resources that are now being evaluated.

The Off-Shore Banks of the Atlantic

The North Atlantic is the greatest fish basket in the world.

Its off-shore banks are great shallows a few hundred feet below the surface, warmed by the sun and rich in vegetation. Small animals—zooplankton—eat the plants and are eaten in turn by large schools of fish. There are twenty-eight basic species.

There are many banks but two are supreme—the Grand Banks, southeast of Newfoundland, and Georges Bank, due east of Massachusetts and southwest of Nova Scotia.

Each year fishermen take millions of tons of cod and herring (the most important), haddock and hake, and hundreds of thousands of tons of scallops and lobsters from the banks.

The cod family is in a class by itself since it includes most of the major commercial fish—atlantic cod, haddock, pollock, common hake and cusk. They resemble each other but can be distinguished by their size and the line of their dorsal fins.

Atlantic cod, the biggest, can be six feet long and weigh 200 pounds. In earlier years it was dried or salted, but now much of the catch is marketed fresh or frozen. Cod liver, once prized for its nutritious oil, has lost its market to synthetic vitamins.

Scallops are also of special importance since they bring high prices, and the sharing of the scallop beds of Georges Bank is a serious point of contention between Canada and the United States. They are mollusks with ridged, wavy-edged shells, measuring two to six inches from front to back. They do not attach themselves to the ocean bottom but move about by opening their shells wide to let water in, then snapping them shut and forcing the water out. The muscle which opens and closes the shell is the edible part.

Crisis of Fishes

Until the 1950s Americans and Canadians took 90 per cent of the fish harvested, but foreign factory ships, huge and equipped with complex electronic equipment for tracking fish, arrived in growing numbers, stayed for months, cleaning, filleting and freezing the fish as soon as they were caught. By the early 1970s the local fishing fleets were getting less than half the catch.

In 1976 Canada and the United States extended their off-shore economic zones to 200 miles, including the banks, and barred the foreign fleets except under special license. They also set species-by-species limits.

The species have made an impressive comeback.

Since the 200-mile extensions of the two countries overlapped in the Gulf of Maine and on Georges Bank, they began negotiating the sharing and management of these traditional fishing grounds. They agreed that the boundary line would be decided by an international tribunal. A separate treaty setting quotas, fixing management responsibilities and providing for periodic adjustments, was signed on March 29, 1979, after eighteen months of complex negotiation.

It was negotiated by committed and knowledgeable people, but when it was presented to the U.S. Senate for ratification it came under attack by New England fishing interests, mainly because of its provisions on scallops. It was withdrawn when it became clear that it would not be ratified. The boundary question is still before the International Court of Arbitration at The Hague.

Whales

Dr. Peter Beamish is trying to talk to the whales in Trinity Bay.

The Bay, off Cape Bonavista in Newfoundland, is one of the world's best places to find the great whales—the blue, the fin, the right whale, the humpback and the minke—the largest ones with baleen (or whalebone) instead of teeth. The fringed plates hang from the roofs of their mouths, and they use them to filter plankton and small fish from the sea.

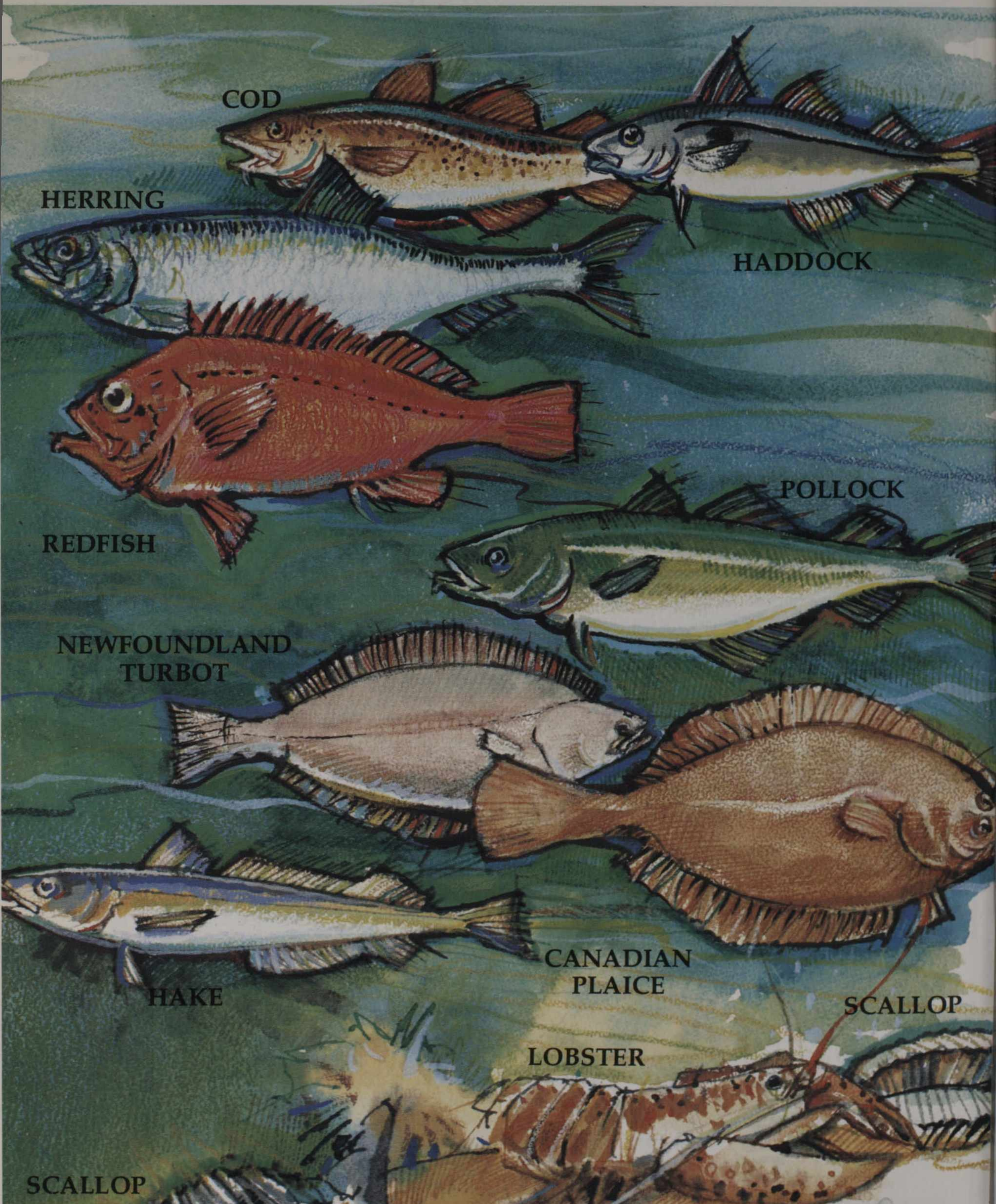
It has been well established that whales talk and sing to each other. Whale songs last about twenty minutes, are highly repetitive and continue for days, with forty to fifty different phrases. The songs change each year, and each year all the whales in the North Atlantic sing the same new song. (Recent research indicates that the songs, when issued with great intensity, stun the sea animals the whale feeds on into insensibility.)

Dr. Beamish, a biologist and acoustician, left his job with the Bedford Institute of Oceanography in 1979 to try some experiments in communication. He hopes to develop a computer-based exchange language combining elements of English and the sounds whales make.

Ben Baxter, his research associate, told *Canadian Geographic* how they intend to make the breakthrough.

"Peter wants to get close to the whales in a boat that has both a receiver and transmitter on it, and send them back to a computer with both a receiver and transmitting signal [at his headquarters in Trinity, 160 miles northwest of St. John's]. When the whale makes a sound . . . the computer imitates and transmits the same sound. The whale may receive and repeat it but he soon gets bored. We want to move on . . . to more than merely parroting the whale's sounds. That's where the computer comes in—it helps us innovate in the other animal's language."

Canada's Atlantic Harvest



The Bedford Institute

Canada is a leader in oceanographic research.

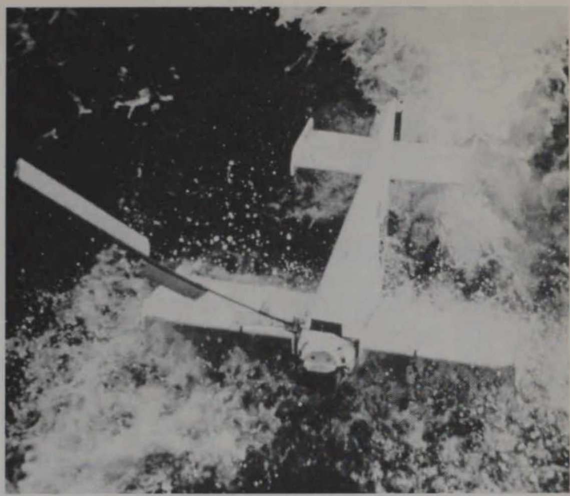
The federal government spends $72.4 million a year gathering information about the oceans. The Department of Fisheries and Oceans, the Department of Energy, Mines and Resources, and the Canadian Forces are all engaged; and the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, which is government-supported, is one of three major oceanic research centres in the world. (The others are Woods Hole in Massachusetts and the Scripps Institution in California.)

Bedford has more than 1,000 employees and is part of a public complex that includes the Nova Scotia Research Foundation, the Micmac Lake Centre, the Technological University of Nova Scotia and Dalhousie University.

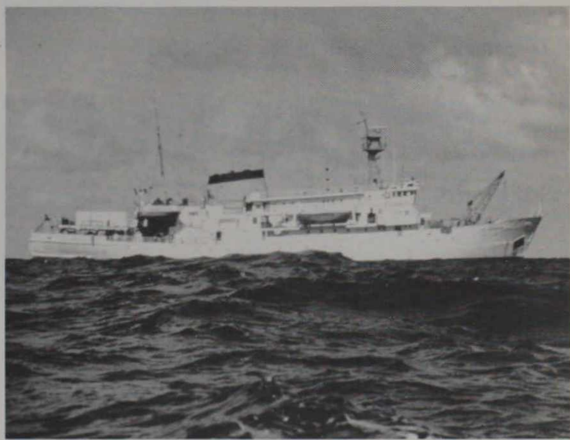
It has 12,000 books, 11,000 reports and 100 on-line data bases in its library; three major research ships, *CSS Hudson, CSS Baffin* and *CSS Dolphin*, and various auxiliary vessels scattered around the waters of the world. It also has the Batfish, a remote-control underwater monitor that measures temperature, salt, light, chlorophyll, fluorescence and conductivity. The Batfish has an electrically-powered hardrock drill that can bore holes in seabed rock 10,000 feet deep.

Much of the Institute's research, such as the gathering of information on the circulation of the oceans' waters, is basic and long-term; some, such as that dealing with fish populations and movements, has immediate application.

Last summer the Institute and Dalhousie were hosts to about 700 scientists from all over the world at the Joint Oceanographic Assembly, the first assembly held in North America. It focused on weather and water. Kenneth Hare, a meteorologist at the University of Toronto and co-chairman of the National Academy of Sciences and the Royal Society of Canada's Joint Committee on Acid Precipitation, gave the keynote address. He predicted that if mankind continues to burn fossil fuels at present or greater rates the increase in carbon dioxide in the earth's atmosphere will make the weather noticeably warmer in twenty years and will change the climate of the earth in a century. He said it will melt snow and ice at the poles and cause ocean levels to rise ten feet, flooding coastal cities.



The Batfish.



CSS Hudson.

The *Hudson*: Pingoes, Chimneys and Benthic Storms

In 1970, the Institute's flagship CSS *Hudson* became the first ship to circumnavigate the Americas, sailing 58,000 miles, from Halifax, N.S., to Antarctica, to Vancouver, through the Beaufort Sea and Baffin Bay, around Newfoundland and back to Halifax.

In the Beaufort it discovered submerged pingoes, cones of antediluvian ice coated with frozen muck, sticking up like dirty spearheads, some within forty feet of the surface. They could pierce and rip the bottom of a ship the way a knife can gut a fish.

Two years ago the *Hudson* completed its detailed survey of the pingoes, providing navigators with their precise locations and making it safe to bring out Arctic gas and oil in deep-draft ships.

Last year the *Hudson* worked in the Norwegian Sea monitoring the movement of heavy, cool, saline waters as they sank to the ocean's floor and interacted with the warmer waters. The project was part of an international survey, and while the *Hudson* was doing its work the U.S. drilling ship *Glomar Challenger* was winding up a three-year effort in the Pacific where it drilled 4,429 feet down below the bottom floor.

The project—which involved ships in the Atlantic, Pacific and Indian Oceans, the Scripps Institution of Oceanography and scientists from a number of universities—has enormously expanded man's knowledge of the way oceans behave. The most significant finding was that a volume of water equal to the water in all the

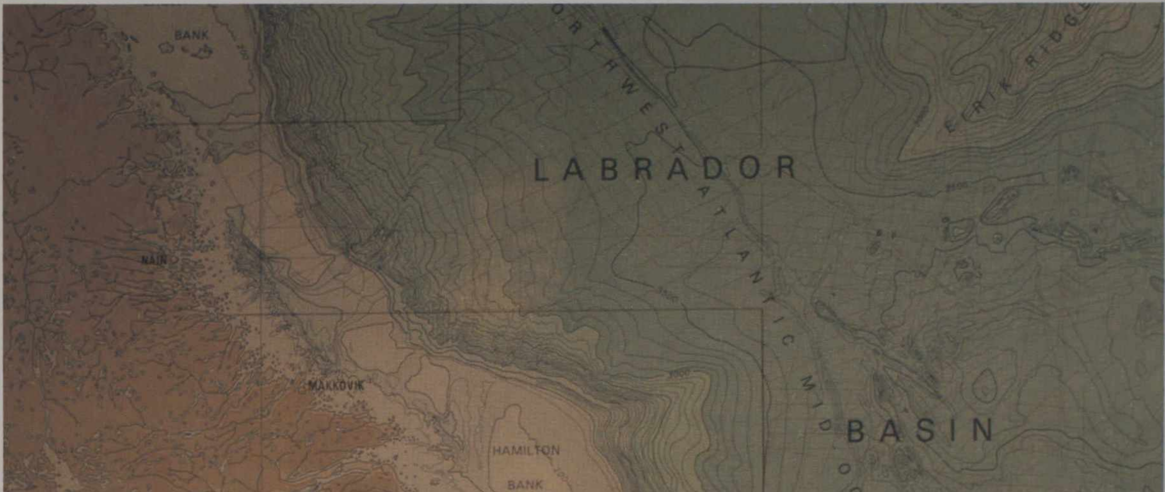
PHOTOS: DEPARTMENT OF FISHERIES AND OCEANS; CANADIAN HYDROGRAPHIC SERVICE

An instrument cluster used for water sampling.

oceans circulates through the porous ocean floor every eight to ten million years. It becomes superheated, and as it percolates it leaches various elements—potassium, calcium, silicon, iron, lithium and manganese—from the crust.

The Institute was also much involved in a cooperative project with Woods Hole called Hebble, for High Energy Benthic Boundary Layer Experiment. The Bedford scientists monitored current meters attached to buoyed mooring lines at various places between the Grand Banks and the outer edge of the continental shelf south of Cape Cod. They discovered two great currents on the floor of the northwest Atlantic, carrying water masses measured in cubic miles in clockwise and counter-clockwise "gyres" near the New England sea mounts, a chain of extinct volcanoes.

The scientists also found that "benthic storms" sweep the deep, deep sea, stirring up blizzards of sediment and leaving grooves in the ocean floor.



A section of the General Bathymetric Chart of the Oceans, showing the waters off Labrador and Newfoundland.

Floor Plan

Last year the Canadian Hydrographic Service published the eighteenth and final sheet of the General Bathymetric Chart of the Oceans.

The complete chart gives the depths and configurations of all the oceans' floor, and it is now the premier reference work for oceanographers.

The first such chart was produced with the active support of Prince Albert I of Monaco in 1903. A second was issued between 1912 and 1930 and a third in the late 1930s. A fourth edition was begun but only two sheets had appeared by 1961.

In 1974 the member nations of the International Hydrographic Organization of Monaco and the United Nations' affiliated group, the Intergovernmental Oceanographic Commission, agreed that a new issue was needed and Canada volunteered.

The new sheets are by far the most precise ever produced since the cartographers had the great advantage of working not only with the echo-sounding techniques that give a moving vessel a continuous reading of the ocean bottom, which had been developed in the 1930s, but also with computers and long-range electronic navigation equipment which can fix a ship's precise position at any given moment.

Sixteen of the sheets are on a scale of 1:10,000,000, the two polar ones, 1:6,000,000. This means that one inch on the charts represents 150 miles in the first case and 100 miles in the second. Spliced together, as they are on the wall of the Hydrographic Service in Ottawa, they are slightly more than thirteen feet wide.

Joe Ploeg's Waves

Joe Ploeg and the Hydraulics Laboratory at the National Research Council have been studying episodic waves since 1976.

The waves occur most often on the sheer edge of a continental shelf when tides, winds and currents interact in a certain way. They are called episodic because they were first believed to be rare. They have proved, however, to be relatively common. They come in sequence and as one overtakes another they build up, perhaps to a crest of 100 feet that then breaks, destroying ships, breakwaters or whatever happens to be in its path.

Ploeg has created test waves in the lab by computer. His system can be used in designing wave-resistant breakwaters and buoys.

Insurance companies have designated certain areas of Norway and South Africa as susceptible to the waves and will not insure ships traveling in them.

One possibility awaiting further investigation is that ships lost in the Bermuda Triangle may have been hit by such waves.

Hudson Bay

Hudson Bay is rich in copper, silver, uranium, iron, nickel and zinc, but much of its riches are now—and perhaps always will be—beyond anyone's avarice.

The Bay is huge, 320,000 square miles, and inhospitable. It was squashed into shape 10,000 years ago when the area was covered by a mile-thick lid of ice. It is still covered most of the year,

Hudson Bay, off Churchill, Manitoba.

the sea and shore merging under a wind-sculptured blanket of ice and snow.

It is surrounded by bleak land and few people. In July and August grain ships from northern Europe come to the port of Churchill, Manitoba, and barges from Churchill carry supplies to the tiny Inuit villages scattered around the Bay's edges.

The Bay has islands, all bleak, most uninhabited.

One, Marble Island, a pearly quartzite monolith streaked with rose, tan and gray which rises, free of vegetation, out of the water, was the last home of James Knight, commanding officer of the *Albany* and *Discovery*, who went looking for the Northwest Passage in 1719 at the age of eighty. His remains were found on the island forty years later. It hasn't been inhabited since.

Digges Island, with cliffs 600 feet above the Hudson Strait, has no people, but for a time each year it is the home of some 500,000 murres. They look like diminutive penguins and have a maniacal laugh. In the summer the chicks hatch on the narrow ledges of the cliffs, and then the entire colony swims through the Strait to the Atlantic and then down the coast to Labrador and Newfoundland, some 1,500 miles.

There are other non-human inhabitants scattered around. The polar bears spend the fall, winter and spring out on the Bay's ice, but when it breaks up in early July they are forced to come ashore. Some 500 of them, the largest concentration in the world, make their way up the western coast, reaching Churchill in the fall, where they ransack the town garbage dump and keep the inhabitants at home after sundown. When the Bay freezes, they go back out on the ice where they prefer to be.

The Bay has five species of seal and four of whale. It has about 9,000 belugas, and the native peoples are allowed to kill about 200 a year, for a skin and blubber delicacy called *muktuk*.

On and Off the Pacific Coast

Some twenty years ago the theory of plate tectonics revolutionized the scientific concept of the structure of the earth.

The theory has been greatly refined in recent years and much of the basic work has been done by Canadian and American scientists. Two, James Monger of Canada's Geological Survey and Charles Ross of Western Washington State University, have expanded it to account for certain coastal formations.

The original theory held that the crust of the earth is made up of seven large, rigid plates and several small ones. Five of the large plates carry the continents; two are under the oceans. The small ones may carry islands, underwater ridges or plateaus. The ones carrying continents have a relatively light granite crust about twenty-two miles thick under the land mass. Below that is a heavier basaltic crust about six miles thick. The ocean-carrying plates have only the basaltic crust. They all float on a plastic layer called the earth's mantle and move around slowly, sometimes colliding, sometimes drawing apart. When the present continents separated, the plastic mantle produced lines of basaltic volcanoes which became the mid-oceanic ridges.

When an ocean-carrying plate with a heavy basaltic crust collides with a continent-carrying plate, it may dive beneath it, generating great heat and forming arcs of volcanic islands above. The so-called "Ring of Fire" rimming the Pacific Ocean was formed this way.

When plates carrying continents collide the lighter crusts pile up, forming coastal mountains, the most spectacular being the Himalayan chain, which came into being when the plate carrying India bumped into the plate carrying Asia.

In 1971 Monger and Ross found fossils of one-cell sea animals called fusulinids in the mountains of British Columbia. The small creatures had lived hundreds of millions of years ago in the shallow seas that surround China, Japan and Indonesia.

Other scientists in other places found other rocks and fossils in unlikely places.

Monger and Ross made some bold suggestions.

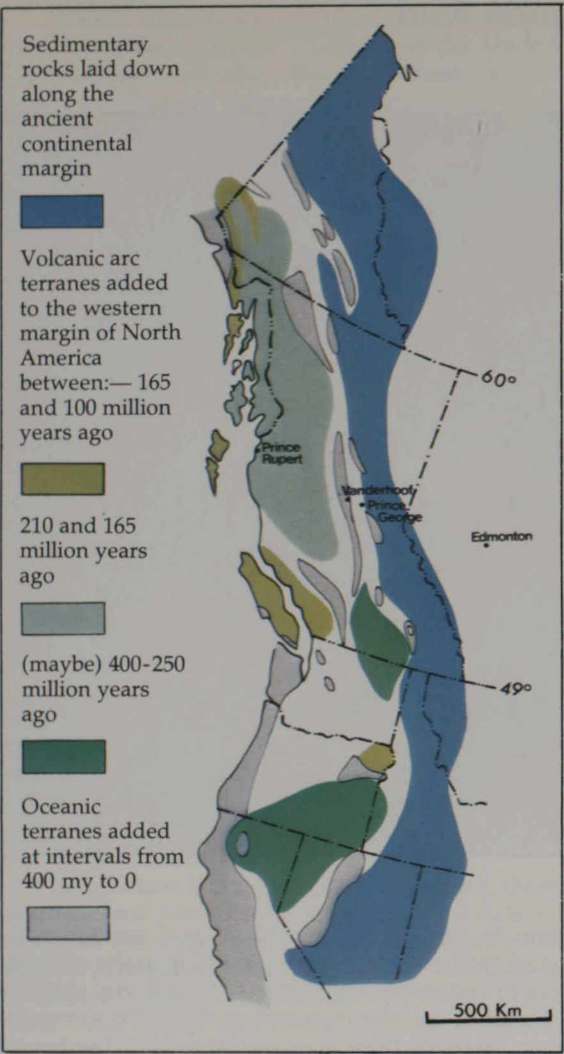
Canada's West Coast, including the continental shelf and the Rockies (as well as most of Alaska, the coasts of Washington and Oregon and a lot of California), had arrived at their present locations rather recently, billions of years after the rest of North America had been formed.

Furthermore, since the fossils had originated in the south, the plate carrying them must have been moving north.

This challenged a basic assumption of the plate tectonics theory, that movements were east and west and that the North American Rockies had been formed when the Pacific plate moved eastward beneath the North American plate. The collision must have been more in the nature of a sideswipe.

The two scientists continued to accumulate evidence. They identified rocks and fossils, then compared them with adjacent geological layers. Fossils that had originated in southeast Asia, for example, were found just across a fault line from fossils from the Arctic; and the magnetic field preserved in the rocks on one side had been formed 350 million years ago, about 3,600 miles south of their present location, while those on the

PHOTO: GORDON W. SMITH, B.C. MINISTRY OF ENVIRONMENT, FISH AND WILDLIFE BRANCH



The geographic base of western North America. Driving from Edmonton to Prince Rupert, B.C., you would cross the ancient continental margin near Prince George, a sliver of ancestral Pacific Ocean near Vanderhoof and on to a fragment that was probably originally located far to the south of its present position.

other side had been formed 250 million years later, some 1,000 miles to the west.

It became increasingly clear that the Pacific continental shelf and much of the West Coast growth had resulted from land movements from the south, and that the process was still going on.

Baja California and the narrow slice of California west of the San Andreas fault, for example, are sliding northward at the rate of about two inches a year. In time Los Angeles will be a suburb of San Francisco. Fifty million years from now it will have worked its way up to Alaska.

Geologists in Canada, the United States and Mexico are now putting together huge colour maps which will show the origins of all the land west of the Rockies, from Alaska to Guatemala. Japan will map its own coasts, and other countries in the western Pacific may do the same.

The Return of the Sea Otter

The sea otter, a clever, endearing mammal with a walrus (or sea otter) mustache, has been more or less extinct along the British Columbia coast for a hundred years.

They returned some ten years ago and they seem to be thriving.

The otter is one of the few mammals—with man, the chimpanzee and the gorilla—that use tools. They feed while floating on their backs, using stones to crack mussels. They have other distinctive features including a pocket—a loose fold of skin across the front and under the arm-pits—in which they can carry twenty-five sea urchins or clams until they are ready to eat them.

They also have what is considered the finest fur in the world, so silky and thick that it doesn't seem real. They were once abundant from Japan to Mexico, but their pelts brought as much as $2,000 each and they were hunted almost to extermination in the eighteenth century.

In 1911 Canada, Russia, Japan and the United States agreed to protect them, but at that point only a few were left, most of them in the Aleutians.

By 1965 the population had increased to an estimated 32,000—most still in the Aleutians but some 5,000 in Russian waters and 600 off Monterey, California. After many failures, Karl Kenyon of the U.S. Bureau of Sports Fisheries and Wildlife succeeded in moving seven to St. Paul in the Pribilof Islands off Alaska in 1959, and some 400 more were transplanted in the next ten years.

In 1966 Ian MacAskie and Don Blood made arrangements for Alaska to give forty sea otters to British Columbia.

In 1969 the first batch was carried successfully to Checleset Bay on the northwest coast of Vancouver Island, and more followed in 1970 and 1972.

A census in 1977 counted fifty-five at Checleset Bay on the northwest coast of Vancouver Island and fifteen at Bajo Reef, forty-five miles away.

PHOTO: DOUG LEIGHTON

Pacific Salmon Run

Spawning salmon.

The salmon begins in the autumn as a tiny red egg buried in wet gravel at the bottom of what will be its own particular river.

It grows until it breaks its capsule in the spring, and it remains in the dark spaces between pebbles until the yolk is gone.

It is already marked for life—it is a member of a particular branch of the salmon family, sockeye, pink, coho, chinook or chum, and small variations in its scales show it to be a native of a specific branch of a specific river.

It will now pursue a life cycle appropriate to its kind. If it is a pink or chum it will have little taste for fresh water and will head for the sea at once. If it is a chinook it will remain in place for three months, feeding first on plankton, then on insects and smaller fish. If it is a coho it may stay at home for three years.

Some coho and chinook spend most of the rest of their lives near the eastern coast of Vancouver Island, but most British Columbian salmon go north to the Gulf of Alaska along the continental shelf. By mid-winter the majority of these will have made their way out to the mid-Pacific.

As the salmon reach maturity in the ocean they start to return home.

They retrace their migration path with uncanny precision, up the main river, then each into its own tributary.

They wait in pools at the mouth of the spawning stream as the eggs mature within the female and the milt within the male. Then the female finds a proper place and scoops out a pocket of gravel while surrounding males compete for her attention. She outlines the general shape of the nest, and the favoured male swims alongside her. Together they repel any intruders. The female whisks the stream bottom with her tail to enlarge the nest and deposits the eggs in a deep pocket in the centre. The male joins her over the pocket, and both eggs and sperm are released together. At this point they are often jolted by unspawned males trying to fertilize some of the eggs. After spawning, the female covers the eggs with material excavated from a new nest upstream. She digs and fills one nest after another until she has deposited between 500 and 1,000 eggs.

Salmon fade rapidly after spawning, and soon dead and dying fish litter the banks. Birds and mammals gather to gorge on the remains.

Balanced Scales

Canada and the United States have been negotiating Pacific salmon harvests for seventy years.

They began, slowly, in 1913, when a rock slide caused by railway construction blocked the Fraser River at Hells Gate and threatened the system's salmon run. The Fraser is one of North America's great spawning grounds, and both countries were concerned since American and Canadian fishermen share the fish that return to the river through the internationally divided waters of the Strait of Juan de Fuca.

In 1937, Canada and the United States ratified the Convention between Canada and the United States for the Protection, Preservation and Extension of the Sockeye Salmon Fisheries in the Fraser River System, and formed the International Pacific Salmon Fisheries Commission (IPSFC). In 1957 the Convention was amended to apply to pink salmon as well as sockeye.

In 1952, the two nations and Japan signed the International North Pacific Fisheries Convention. Japan agreed to place restraints on its high seas salmon fleet.

In 1971 the two countries began negotiating a coast-wide treaty covering all salmon species, from the Columbia River in the south to the Yukon in the north.

In 1977, when both countries extended their fishing jurisdictions to 200 miles, the negotiations grew more complex.

A draft treaty providing for the conservation and management of salmon was initialled in February of this year by the negotiators from both countries but has not been ratified. It contains agreed management plans for the major intercepting fisheries of the United States and Canada. The Treaty would set up an international commission to act as a forum to discuss fishery management, research and enhancement. The State of Alaska has, however, objected to some provisions of the proposed treaty, and the United States has made some proposals for a revision. These are under review.

The Law of the Sea

The nations of the world, coastal and landlocked, began negotiating an inclusive Convention on the Law of the Sea in 1971.

In this century the sea has become a place to be mined for oil, gas and minerals and to be fished by floating factories, and which could be damaged and possibly destroyed.

Each nation has its special interests but there are three basic viewpoints. Major maritime nations wish the sea to remain as free for navigation as possible, coastal nations wish to have jurisdiction in adjacent waters, and landlocked nations and those with small continental shelves want the mineral resources of the sea to be exploited for the benefit of all mankind.

The most interesting of the mineral resources are in the form of nodules of manganese, nickel, copper and cobalt, the size and shape of potatoes, which lie in layers on the ocean's floor. Some are in shallow waters, as off Scotland, but the most commercially valuable are found in the Pacific at depths of 13,000 to 16,000 feet.

The nodules could be harvested by high technology instruments, such as continuous-line bucket dredges, but this would require enormous investments.

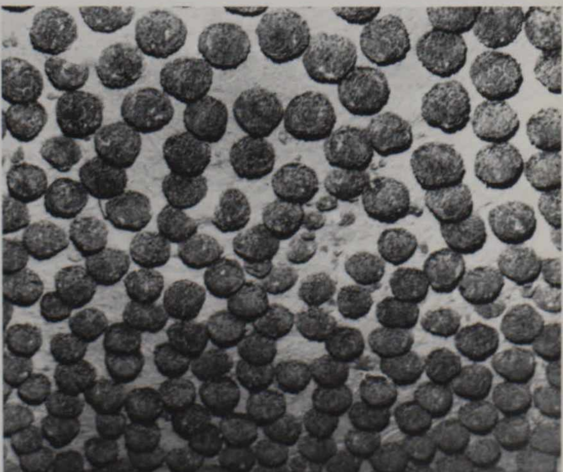
In the course of eleven years of negotiating, it was generally agreed that the nodules in no-man's-waters should be supervised by an International Seabed Authority, but it proved much more difficult to obtain unanimous agreement on specifics for development and profit sharing.

In April 1982 the majority of the nations, including Canada, voted for the United Nations Convention on the Law of the Sea, which gave the International Seabed Authority effective control of mining of the seabed but permits mining by private companies. The treaty also defined territorial sea limits, established 200-mile exclusive economic zones providing coastal state control over fish stocks, defined the continental shelf and provided for protection of the marine environment and for peaceful resolution of sea disputes. Several industrial nations abstained from voting and the United States voted against it.

Canada and 120 other nations signed the Convention in Jamaica in December 1982, and Japan signed in January. The U.S., Great Britain, West Germany, Italy and Belgium did not sign.

On March 10 of this year President Reagan issued a proclamation claiming ownership of fish and mineral rights in a 200-mile exclusive economic zone off the American coast. An accompanying policy statement said that seabed mining in waters beyond the zone was a freedom of the high seas.

Canada's position is that seabed mining must be governed by the Law of the Sea Convention, and it is opposed to any unilateral actions to conduct mining outside the Convention.



Manganese nodules on the floor of the Pacific Ocean, at a depth of 18,000 feet.

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