# HYDROGRAPHIC SURVEYS IN THE ARCTIC

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The charting of a virtually unmapped sea, a hydrographic surveying project unique in modern times, was assigned to the Navy Hydrographic Office in 1954. Not many such waters remain; most have been covered at least by reconnaissance surveys, but the southern part of the Canadian Archipelago was singularly unknown.

Plans were being made to build a chain of radar stations, spaced 50 miles apart, from the Pacific to the Atlantic ocean to form the Distant Early Warning Line (DEW Line). The stations of the line would form a radar barrier, to give warning of any air attack from the north. Each station had to be built in a wilderness with its own living quarters, roads, garages, airstrip, hangar, fuels, storage tanks, radio, and radar. This would involve a major transportation project to get the materials and supplies to the sites. The Air Force asked the Navy Military Sea Transportation Service (MSTS) to move the cargo by sealift, starting in the summer of 1955. MSTS examined the charts of the area, and requested the Hydrographer to make more adequate charts.

Eliminating the coast of Alaska, which had been partially surveyed, there remained over 1 000 miles of ship routes through Canadian waters to be investigated. Each summer there is a period of from one to three months during which survey ships may enter, carry out their work, and withdraw prior to the onset of winter.

The first ship transit of the Northwest Passage had been completed fifty years previously by Amundsen in the *Gjoa;* more recently, Inspector Larsen, of the Royal Canadian Mounted Police, had repeatedly taken the *St. Roch* through the area, resupplying the scattered police posts. Ships of the Hudson's Bay Company and other traders had hauled in supplies and brought out furs. In most cases, however, the vessels were relatively small. They coasted along between settlements, following the same route each trip because experience had shown that deviation meant danger. Unfortunately, their navigation had generally been by « seaman's eye », and they had made few accurate records of their positions and soundings. The available charts had changed little in eighty years; soundings on many of them were so scarce that they might more properly be called maps than nautical charts. Blocked off from outside shipping by pack ice for nine months of the year, and with little to attract visitors, it is not surprising that the area remained so long uncharted.

## SURVEY PLANS

To accomplish as much as possible in the limited time, the surveys were phased over a three-year period. During the first year, survey ships would make reconnaissance runs through the route ahead of the cargo ships, to locate and explore any major danger spots. Cargo was to be landed over the beach, in amphibious operations, so survey teams would be needed ashore to investigate the beaches and approaches. Wintering-in havens should also be surveyed for use in case ice conditions prevented withdrawal of the shipping after the operation. During the second year, a geodetic party would be airlifted into the area early in the season, to establish triangulation nets where reconnaissance had shown a need for precise surveys. Later in the summer, when ice conditions permitted, the survey ships would enter and take soundings, using the new geodetic framework for precise positioning. During the third summer season, the detailed hydrographic surveys would be continued and completed. During all seasons, navigational aids would be built and located. Oceanographic observations would be taken periodically during the survey. When an opportunity arose, reconnaissance surveys would be conducted to the north and east, to investigate the possibility of a deep-draft ship passage from the central DEW Line to the Atlantic Ocean. (See the map, figure 1.)

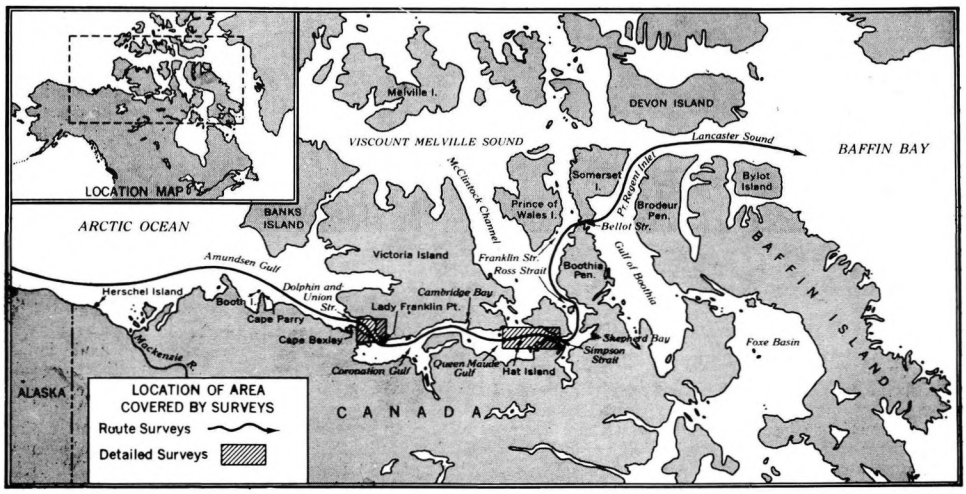


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Fig. 1. Route of the Hydrographic Survey through the Northwest Passage.

Since most of the surveys were to be made immediately ahead of the cargo ship operations, speedy processing and dissemination of results were mandatory. It was planned that all field surveys would be plotted on master sheets and kept up to date so that field reproductions could be distributed to the cargo ships. Radio message reports were scheduled to be sent to the Task Group, giving safe tracks to follow, dangers to be avoided, and general navigational information. At the conclusion of each summer's work, the season's data would be processed at the Washington Office and put into new charts.

## OPERATIONS, 1955

The survey ship selected was the USS *Requisite,* a minesweeper converted for survey duty. Although she was somewhat strengthened to resist ice damage, her relatively light hull and vulnerable screws and rudder were serious handicaps in the pack ice. Already fitted with standard hydrographic survey equipment, she was also given an oceanographic winch and equipment for sampling the sea floor. Accompanying her was the Coast Guard Cutter *Storis,* an Arctic buoy tender. Designed to work in ice, with a strengthened hull, ice-breaker bow, and single deep screw, she performed admirably. A survey echosounder and a shortrange sonar used to search for shoals were added. A flight deck was installed aft to accommodate the small two-man HTL Bell helicopters which were especially useful. A hydrographic officer and two civilian hydrographers were assigned to the technical work.

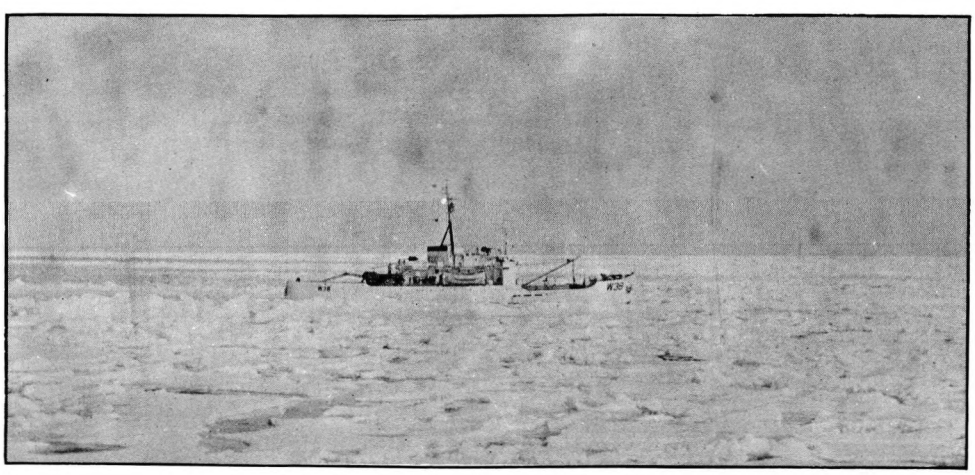

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Fig. 2. — Coast Guard Cutter *Storis* in Heavy Pack Ice.

The two ships worked as a unit of Task Group 5.1, the Pacific DEW Line sealift command, and sailed early in the summer of 1955 in an attempt to reach the survey area well ahead of the cargo ships. Ice conditions along the Alaskan coast were unfavorable. Even with icebreaker escort, Amundsen Gulf was not reached until August 1. Conditions were considerably better after the ships entered the Archipelago, and they were able to steam along the desired cargo ship track from site to site through Amundsen and Coronation Gulfs without hindrance by ice. Frequently, a ship's boat, equipped with portable echosounder, scouted ahead to give advance warning of sudden shoaling; the helicopters were in steady use to provide ice information or to spot reefs.

The ships generally ran abreast, a half mile apart, thus providing two parallel tracks of soundings. Whenever shoals were found, special developments were run, crisscrossing the vicinity to delineate the dangers and find a way through or around them. At each radar station site, a track was

sounded from the main ship route in toward the beaching area. The survey ships could only be positioned by reference to the coastline, islands, and site buildings, since there were no standard navigational aids. Sextant angles, gyro bearings, and radar ranges were all used to give the most accurate navigational fix obtainable under the circumstances.

Eastward from the Mackenzie delta, the expedition found mostly deep, safe water, but extensive shoaling was encountered in Dolphin and Union Strait. That strait has a number of islands down its center, and considerable work was required to develop and buoy a channel past them. From there eastward, through Coronation Gulf and Dease Strait, the water was again generally deep, and practically no ice was seen.

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Fig. 3. — Many of the small, low-lying islands along the Dew line are almost covered by the shifting winter pack ice. All of them had to be precisely located and charted. Shown is Nell Island, in Dolphin and Union Strait, with a survey marker on it.

It was a severe shock upon entering Queen Maud Gulf, to find it a nightmare of ice and shoals. This Gulf is cluttered with thousands of low-lying gravel islands, which provide very poor radar or visual targets. Interspersed among the islands are submerged banks and ridges, frequently rising to within a few feet of the water surface. Several reconnaissance lines were run in an attempt to find a safe passage through the maze of islands. Finally transit was made through the southeastern part of the gulf to Simpson Strait, along the route used by Inspector Larson in the *St. Roch*. Simpson Strait was free of ice, but otherwise showed little improvement to the surveyors. Dotted with islands and bars, which in some places narrow the channel to 500 yards, the strait is quite shoal. With the cargo ships pressing close behind, a channel was surveyed and buoyed. It could be considered barely satisfactory, since in some places the ships crossed shoals with less than 10 feet under their keels, and the narrow passage and strong currents made ship-handling difficult. It was a welcome relief to clear the strait and pass into the relatively deep waters leading to Shepherd Bay, the end of the line for the cargo ships.

On the return voyage much additional time was spent sounding in Queen Maud Gulf, and a different route through the islands was located, which was a considerable improvement over the previous track. Continuing

westward, surveys were made of possible wintering-in havens at Booth Island, near Cape Parry, and at Herschel Island near the Mackenzie delta. During the season, ninety-two oceanographic stations, spaced at 20-mile intervals, were taken along the route. Observations included water temperature, salinity, transparency, and color; cores of the bottom; biological specimen hauls; and ice and weather data. Measurements of currents were made at sixteen stations along the route.

To complement the offshore surveys, ten 6-man parties had been airlifted to the DEW Line to conduct nearshore surveys of beaches, anchorages, and approaches. The parties were composed of hydrographic officers, civilians, and underwater demolition officers and men. Site surveys were begun in mid-June with the establishment at each site of either triangulation or traverse networks to provide control points for the local, large-scale surveys. The teams worked from site to site, selecting suitable landing beaches, determining beach profiles, and establishing range markers for anchoring and beaching operations. Offshore work usually consisted of charting a passage three-quarters of a mile wide extending out from the beach into navigationally safe water, and joining to the offshore ship surveys. Sounding surveys were run in 18-foot aluminium boats, powered by outboard motors and equipped with portable echosounders. Positioning of the survey boats was by three-point sextant fix to the control points established on the beach. The results of these surveys were plotted on the scene, and field reproductions were distributed to the cargo ships.

## OPERATIONS, 1956

On examining the results of the 1955 reconnaissance work, it was apparent that further hydrographic work along the DEW Line should be concentrated in Dolphin and Union Strait, Queen Maud Gulf, and Simpson Strait. Minor work would be required around Cambridge Bay, Cape Parry, and Cape Bexley. To set up a control network for these surveys, an advance geodetic party was airlifted to the DEW Line in late May 1956, and remained there until mid-September. The technical personnel consisted of two hydrographic officers and six civilian hydrographers, as well as one hydrographer from the Canadian Hydrographic Service.

The terrain, mostly barren tundra covered with swamps and lakes, and low, rolling gravel ridges, precluded travel by foot or wheeled vehicle. For transportation the party depended entirely on two Navy HO4S Sikorski helicopters, of moderately large capacity. The geodetic party and plane crews lived in the construction camps and operated from them throughout the summer season, moving from one to the next as the triangulation net was carried forward. Because of the large territory to be covered and the short time available, third order triangulation was selected as providing satisfactory accuracy with the least field work.

All phases of the operation were designed for high speed. The survey signals, light wooden tripods 16 feet high and covered with cloth, were prefabricated and could be erected by two men in less than an hour. As there was practically no chance of any marker being disturbed, conventional concrete monuments were dispensed with and instead of them long iron rods driven into the permafrost and covered with cairns of rocks were

used. Leapfrogging the parties was found to be an effective system : one helicopter worked ahead, carrying a reconnaissance and signal-building party that selected and constructed the triangulation stations; the other plane followed with two two-man observing parties, that it shuttled from one station to the next, allowing each party time to mark, describe, photo-identify, and occupy the station. Weather too poor for either flying or observing could be expected at least a third of the time, so every advantage was taken, during good weather, of the long daylight hours, and 16-hour working days were not uncommon.

At each radar station site, connections were made to the construction contractor's land-survey traverse; ties were also made to the previous hydrographic local traverse or triangulation nets. In addition, check baselines about a mile long were measured by subtense bar at alternate sites. Origin for the Dolphin and Union Strait network was a local astronomical position at Lady Franklin Point; the Simpson Strait-Cambridge Bay net was adjusted to the North American Datum at a point provided by the Canadian Shoran Station at Cambridge Bay. A total of 55 miles of triangulation was run through Dolphin and Union Strait, using 27 stations in 10 figures. From Cambridge Bay to Simpson Strait 230 miles of triangulation was completed, using 102 stations in 36 figures.

Fortunately, the geodetic work in Dolphin and Union Strait, Simpson Strait, and most of Queen Maud Gulf had been completed by the time the survey ships were able to enter the area, and field-corrected sheets were provided for their use in sounding. *Requisite* and *Storis* had again been assigned to survey work, and en route to the primary areas, had run limited surveys off Cape Parry and Cape Bexley. Farther southeast in Dolphin and Union Strait, extensive soundings were run to establish a safe channel down its eastern side. The two ships spent the remainder of the season surveying the shoal areas of Queen Maud Gulf and Simpson Strait, fixing their position variously by sextant angles, bearings, or radar ranges depending upon the locality and visibility. The Coast Guard Cutters *Sedge* and *Citrus,* small buoy tenders which had been assigned a secondary mission of surveying, found time to contribute limited boat surveys in Simpson Strait and the approaches to Cambridge Bay.

During the operation several semi-permanent wooden towers with radar reflectors were built at key points to aid in ship navigation. Expendable buoys, fabricated of oil drums, were placed to mark the channel through Simpson Strait.

## OPERATIONS, 1957

At the end of the 1956 survey season, the completion of the operation was almost in sight. Extension of surveys was desirable in Queen Maud Gulf. Although a passable channel had been charted through Simpson Strait, it still remained a sore spot because of its limiting depth of 20 feet, and further exploration was needed to establish a deeper channel. Finally, no reconnaissance had yet been made to investigate the possibility of a deep-draft passage from the central DEW Line to the Atlantic.

For the third successive year, *Storis* was selected to lead the surveys. After two years of battering by the ice, *Requisite* was replaced by the Coast

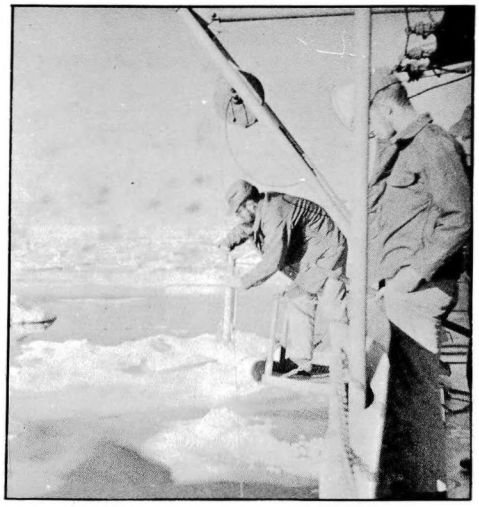

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Fig. 4. — Hydrographer Taking Water Samples on USS *Requisite.*

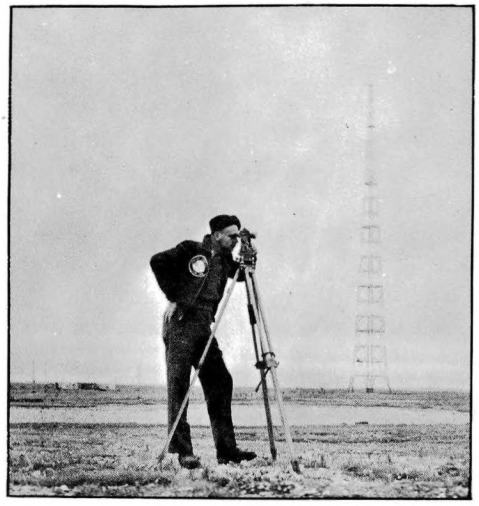

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Fig. 5. — Cdr. T.K. Treadwell sighting in a radio tower in Cambridge Bay.

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Fig. 6. — Triangulation Station on Flat, Barren, Arctic Island. To protect the theodolite and observer from the biting wind and light snow, a temporary windbreak of rocks was built.

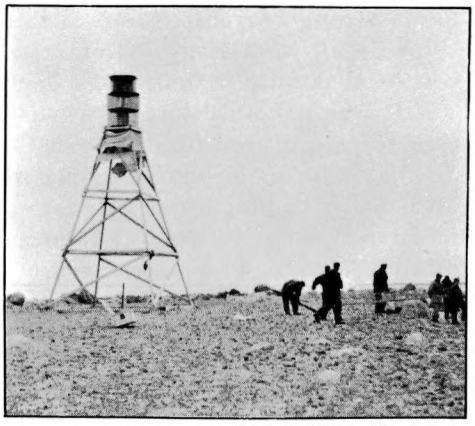

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Fig. 7. — Wooden Tower with Radar Reflector Erected as Navigation Aid.

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Fig. 8. — Arriving in the area to be surveyed in Queen Maud Gulf, the Coast Guard Cutters *Bramble* and *Spar* encounter rough going. Sounding surveys were severely handicapped by the heavy pack ice.

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Fig. 9. — HMCS *Labrador* Leading the Survey Ships through Fog and Pack Ice of the Ross Strait.

Guard Cutters *Spar* and *Bramble,* small buoy tenders much better suited for arctic work. Ice conditions in 1957 were completely reversed from previous years. During 1955 and 1956, difficulty had been experienced along the Alaskan coast, and relatively little ice had been found within the Archipelago. Now, unusually open ice conditions prevailed along the Alaskan coast, permitting the ships to penetrate rapidly as far as Dolphin and Union Strait. Conditions became worse as the ships traveled eastward and on August 1 they were temporarily beset by the heavy pressure of the pack and were unable to move. During this period, shoran equipment for precise positioning of survey lines was airlifted to the DEW Line, and one station was installed at Hat Island in Queen Maud Gulf.

The ice pressure eventually eased enough for the survey ships to work slowly eastward through winter ice to Cambridge Bay. Surveys were conducted and buoys were laid to mark a channel into the harbor. Steaming on to Queen Maud Gulf, the surveyors found the ice coverage far worse than in previous years—so heavy that it was impossible to commence running sounding lines or to install the additional shoran stations. Because of its strong currents, Simpson Strait was practically free of ice, so the ships began work there. After extensive soundings, a much better channel was located, with a controlling depth of 36 feet.

It was not until late in August that the ice opened sufficiently in the Gulf to permit even limited operations. During the short time left to them, *Spar* and *Bramble* managed to cover a large part of the most hazardous area, using combinations of shoran, radar ranges, bearings, and angles to position themselves. During their surveys, the ships installed nineteen aluminum towers with radar reflectors, which had been supplied by the Canadian Government, as permanent navigational aids.

At the end of August *Storis* moved northward to Ross Strait, to start reconnaissance surveys in that passage. This had been an historic bottleneck in the Northwest Passage. Amundsen's *Gjoa* had been grounded and very nearly lost there, and other explorers had reported extensive shallow water. After several days of sounding in and out of pack ice, *Storis* confirmed that many shoals did exist, but that a safe passage could be made between them, with a minimum depth of 36 feet. On September 1 she was joined by *Spar* and *Bramble.* Heavy pack ice lay across their path to the north, and it was obvious that heavy going could be expected.

At the same time, another survey was in progress, 200 miles to the north. HMCS *Labrador,* an icebreaker fitted out as a hydrographic and oceanographic survey ship, was engaged in charting the next bottleneck, Bellot Strait. Although it was believed to be generally deep, Bellot Strait was known to have very strong currents and some shoals. As soon as the survey group in Ross Strait was ready to move northward, the *Labrador* discontinued her work and steamed down to meet them, escorting them into the clear waters of Franklin Strait. The *Labrador* had practically completed charting Bellot Strait, but *Storis, Spar,* and *Bramble* were able to assist by sounding the western approaches. On September 6, their work there was completed. They then sailed through the strait and, escorted by the *Labrador,* worked northward into open water in Prince Regent Inlet. From there on it was clear sailing to the United States via Lancaster Sound and Baffin Bay. They thus became the first American ships to complete the Northwest Passage.

## ACCOMPLISHMENTS

The operation as a whole was success. The cargo was delivered, the DEW Line was built and put into operation, and all ships returned safely with no losses and surprisingly little damage. Over 1 000 miles of sealanes along the DEW Line in central Canada were covered by reconnaissance surveys and a safe shipping route was charted through it. Five hundred square miles of detailed hydrographic surveys were made in the most critical areas. At each radar station site, the landing beaches and approaches were charted. Some 285 miles of coastline were covered by triangulation, and 28 radar reflector towers were built as navigational aids. The oceanographic picture of a previously unknown area was sketched in, and its variations studied over a three-season period. A deepdraft ship route through the Northwest Passage was verified. The results of the surveys were published in a series of 33 charts, and in greatly improved sailing directions. And, by no means least of all, the Hydrographic Office acquired new experience in the almost forgotten art of scientific exploratory surveys.