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INSTITUTE OF OCEANOGRAPHY
DARTMOUTH, N. S.

SECOND ANNUAL REPORT

1963

B.I.O. 63-6

DECEMBER 1963

PROGRAMMED BY

THE CANADIAN COMMITTEE ON OCEANOGRAPHY

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B E D F O R D I N S T I T U T E O F O C E A N O G R A P H Y
D A R T M O U T H , N . S . - C A N A D A

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SECOND ANNUAL REPORT

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B . I . O . 6 3 - 6

DECEMBER 1963

BEDFORD INSTITUTE OF OCEANOGRAPHY
DEPARTMENT OF MINES AND TECHNICAL SURVEYS
MARINE SCIENCES BRANCH

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1. FOREWORD.

This report covers the first full year of operation of the Bedford Institute, which was officially opened October 25, 1962. The year 1963 has been characterized by vigorous growth of program tempered by stringent personnel austerity. The havoc played by the latter in a new organization at half its planned strength needs no elaboration. It is a tribute to all personnel, from the overworked administrative and technical staff, to the scientists and ships' captains who have struggled along with pitiful support in some vital areas, that the Institute has had a successful and productive year, and that our operations, although hampered, have never broken down.

During the summer, as staff moved in from Ottawa and from educational leave at universities, and as the last few available positions were filled, the planned program for the first phase of the Institute's build-up took shape - at least at the professional level. Theoretical Oceanography and Marine Geophysics groups were established, and Submarine Geology, Current Survey, and additional Hydrographic staff arrived from Ottawa. Engineering services got up to bare subsistence level. Present staff number 134 M&TS, 15 FRB, 5 ICNAF, total 154, in addition to the personnel of the survey/research fleet.

The staff have been heartened by the tremendous interest taken in this new oceanographic institute by scientists, students, and by the general public. We were honoured by being chosen as hosts for the 1963 meeting of the Scientific Committee on Oceanic Research - an honour which it is estimated statistically will not be repeated for two decades. We have also been hosts to practically all of the university science clubs, and most of the high school science classes in the Province of Nova Scotia. We were privileged to be included on the tours of the Canadian National Defence College, the Air Force Staff College, the Army Staff College, and the Foreign Attachés and Commonwealth Service Advisers. We welcomed 250 delegates to the Canadian Mines Ministers Conference, and 450 Alumni of Dalhousie University. In addition, we have been besieged with invitations to speak and requests for tours from community groups. It seems doubtful if even the new Dartmouth brewery will be more warmly welcomed.

We were particularly pleased to welcome to our docks, the R.V. "ATLANTIS II", and to assist in welcoming to Halifax the "POLYUS", "KRUSHENSTERN" and "STVOR", who visited under Naval auspices.

2. THE FUNCTION OF THE INSTITUTE

The Bedford Institute was conceived as Canada's atlantic and arctic center for shipborne surveys and for marine research in the physical sciences. It was set up to meet national requirements in support of fisheries, navigation and maritime defence, and to provide assistance in the delineation of natural resources and in weather forecasting.

In a modern research establishment, basic and applied science go hand in hand. Each depends on the other for information, techniques and motivation. The Bedford Institute's fundamental research is in its infancy, although the results so far promise a modest but worthwhile contribution to man's understanding of his ocean heritage. Applications of science are more tangible, and it is appropriate to ask at this stage what the Institute is doing for its "customers".

Fisheries needs are uppermost in a new program of hydrographic charting emphasizing fishing areas and bottom contouring at a suitable scale. Work on the Nova Scotia Banks, the Grand Banks, the Gulf of St. Lawrence and the Bay of Fundy is in hand. Studies of bottom structure and sediment movement are being undertaken by the geology group, and have a direct bearing on fisheries productivity. Part of the tidal work bears on this problem. The deep water oceanographic cruises yield important information from the point of view of both the larval and adult forms of commercial species, for both respond to water mass character and movement in their survival, growth and concentration. The prediction of oceanographic conditions is of no less interest to fisheries than to maritime defence.

Navigation brings the Hydrographer immediately to mind, for safe navigation demands accurate charts. Despite a vigorous charting program going back many years, much important charting remains to be done in Canadian waters, particularly in the North. The Institute's tidal current program in the Gulf of St. Lawrence also contributes, particularly where ice movements are concerned. Again, in predicting the build-up and dissipation of ice, knowledge of underlying oceanographic conditions, of heat loss or gain, and of the interaction between the wind and the sea, is of fundamental importance. The theoretical study on wave forecasting in the Gulf of St. Lawrence, which was finished at B.I.O. this year, as well as the work on wave recorders, forms another contribution. Looking far ahead; it is conceivable that some day the gravity, magnetic and sub-bottom maps, which our marine geophysicists are starting to produce, might assist the navigator. More probably by that time, his craft will be controlled electronically from a shore operations center.

Maritime Defence needs lie at the root of much of the B.I.O. program in the Arctic, and in the Atlantic as well, where fisheries requirements overlap. Hydrographic charting and oceanographic, geological and geophysical surveys in the North are being carried out each season as conditions and resources permit. This year all programs were hampered during July and August by very heavy ice, but a month long oceanographic-geological-geophysical survey with CCGS "LABRADOR" brought back much new data from as far north as Hall Basin. On the way back, this party occupied the Canadian-U.S. ice-potential stations in Baffin Bay-Davis Strait, for the second consecutive year. B.I.O. has undertaken a comprehensive review of all oceanographic work which has been done in and adjacent to the Canadian Arctic.

Four B.I.O. manned Canadian surveys, and the USS "ATKA" survey with a joint U.S.-Canadian oceanographic staff, made a substantial start in a study of the Labrador Sea and deep North Atlantic in Canada's latitude, an area complicated by the Labrador Current and the Gulf Stream. No system of environmental assessment, for defence, fisheries or any other purpose can reach its full potential without a basic understanding of the water masses, circulation and mixing of this great ocean area.

The whole ocean, from surface to bottom is or soon will be the region of potential submarine and anti-submarine operations. Present detection methods are concerned with the acoustic character of the bottom and with magnetic anomalies. Gravity anomalies, and sub-bottom characteristics could conceivably be important in the future. The Institute's new geophysical and geological programs, which will study all of these, may well provide information useful to defence in due course.

Oceanographic environmental assessment and ultimately prediction, is the goal of a B.I.O. group which late this year was increased from one staff member to five. In addition to the role of two members in the Operational Environmental Centre of Maritime Command Atlantic, the group is responsible for reviewing the results of fundamental programs in the light of possible defence and fisheries applications and for ensuring consideration of defence and fisheries needs in the planning of new projects.

Natural Resources mapping under Canadian coastal waters is mainly the responsibility of the submarine geology group, with aid from the geophysicists. At our latitude, with present

mining technology, it seems that oil discoveries offer the major practical possibility. But there also seems little doubt that this mapping, which will take many years, should be started now, so that the basic information will be available when needed.

Weather Forecasting is a very sophisticated science compared to oceanographic prediction, and it might seem that the oceanographer would have little to contribute to it. However, the annual ice-potential oceanographic surveys by B.I.O., in Baffin Bay-Davis Strait, and in the Gulf of St. Lawrence have been found useful in ice forecasts. Furthermore 3/4 of our globe is covered by the oceans, which are the scene of important moisture and energy exchanges, while nearly all the meteorological observing stations are on land. Hence, it seems likely the meteorologists and oceanographers working together, will be able to make substantial advance. Present staff limitations at B.I.O. prevent more than a token effort in this field.

3. SUPPORT

3.1. Ships

In January 1963, the Masters took over complete responsibility for the internal administration and management of their vessels, including many functions previously assumed by the Hydrographer-in-Charge. At the same time, CSS "BAFFIN", a purely hydrographic vessel since her delivery in 1958, took on oceanographic and geophysical operations, and converted from a 7-month to a 9½-month operating year. Despite a drastic lack of adequate support and guidance from B.I.O. and from Headquarters, despite a rugged schedule and manning difficulties, the ships met every commitment effectively and without complaint.

Statistics for vessels of the M&TS fleet assigned to B.I.O.

	<u>MAXWELL</u>	<u>ACADIA</u>	<u>KAPUSKASING</u>	<u>BAFFIN</u>	<u>HUDSON</u>
Length (feet)	115	182	217	285	293
Days away from base, on operations	146	142	140	164	-
Miles travelled	5,244	3,619	14,862	27,220	-
Number of cruises	2	1	1	4	-

The "HUDSON" was a Christmas present, arriving from the shipbuilders on December 23, 1963. CNAV "SACKVILLE" (205 ft.) operated by the Royal Canadian Navy for the Atlantic Oceanographic Group of the Fisheries Research Board, is programmed with the M&TS vessels, and all are shared between M&TS staff, FRB staff and Dalhousie University Institute of Oceanography staff.

3.2. Engineering Services

The year has seen a considerable expansion in the staff of the group; three engineers and seven electronic technicians have joined during the past twelve months. The ever-increasing demands of the Institute on the engineering group make further staff increases imperative even if we are only to maintain our present rather inadequate support. There is a heavy basic load - in the case of the Depot, launch and diesel engine maintenance, snow removal, and manual labour; in the case of the electronic staff, the maintenance and operation of the electronic equipment, particularly the Decca positioning and other hydrographic equipment. The effort available above the basic load is small so that a small increase in the basic load has a large effect on the rest of the Institute.

Despite, or possibly because of, the pressure of work the group is remarkably enthusiastic. The year began with almost the entire group involved in overhauling equipment - about 50 radios, 12 tellurometers, 50 echo sounders, the Decca Hi-Fix chain, the Decca Two-range chain, 20 launches, and a wide

assortment of other items. The overhaul was completed just in time for the field season, and the main work then turned to maintenance and operation of the equipment in the field.

At the same time, there was a noticeable increase in the design and development work being carried out at the Institute; the summer students were particularly active in this respect and the arrival of the mechanical engineer triggered the depot staff into even more vigorous efforts. In particular the design and construction of the 80 ft. stable mast has involved considerable effort, and the completed mast and anchors, with a total weight of about 50,000 lbs., is to be used in January and February 1964 off Aruba.

Work has commenced on an underwater acoustic pinger, with a design range of several miles, life of many days, but of low cost, and also on a reader for Richardson current meters which records current direction and rate in a digital form. Both these developments have still to be completed. During the last months in 1963, the annual overhaul of equipment was started and in addition, a comprehensive course was held, for all the electronic technicians, on Decca positioning equipment.

3.3. Oceanographic Services

Analytical Chemistry and Salinity Laboratory

The laboratory now has four precision salinometers. The two NIO conductivity bridge units are set up permanently in the laboratory, while the two other bridges are portable. The Autolab inductive salinometer has been used at sea on four major cruises run by the Institute, and has performed satisfactorily. This bridge gives salinities 0.01%, higher than the NIO bridges. The discrepancy is being looked into in a cooperative program with other laboratories. The Hytech model 621 is still being checked out for use.

During the year, 7,200 samples were run in the laboratory for B.I.O., and other laboratories (NRE; DRB Ott.; Arctic Unit Montreal; Ice Forecasting Halifax; IODal). Approximately 4,200 determinations were made at sea with the portable unit, which greatly relieved the load on the laboratory units.

The analytical chemistry section was involved in chemical support work for several of the cruises during the past year and took part in the nutrient chemical analysis aboard CSS "BAFFIN" in connection with the ICNAF survey. This survey

required a great effort to carry out the large number of analyses; exclusive of oxygens and salinity determinations, some 2,500 nutrient analyses were completed. A good deal was learned on this cruise about the problems of carrying out chemical manipulations at sea. Good weather during the cruise allowed all station analyses to be completed. Nutrients analyzed for were phosphate, silicate, nitrate, nitrite, pH and alkalinity.

Bathythermograph Laboratory

Bathythermograph slides were processed as listed below.

<u>Agency</u>	<u>No. of B.T. Slides</u>
DM&TS - Ottawa and Halifax	928
Atlantic Oceanographic Group	624
FRB - St. Andrews and St. John's	1635
RCN	1060
Arctic Unit Montreal	45
Sambro Lightship	676
Miscellaneous	150

17,919 prints of the slides were completed by December 15, 1963 and distributed as follows:

- 1 File copy
- 1 to Contributor
- 1 to Woods Hole, Mass.
- 1 to U.S. Hydrographic Office, Washington, D.C.

During 1963, the changeover from Fahrenheit to Metric recording in bathythermographs has been progressed. It is expected that this project will be almost completed in 1964.

4. RESEARCH AND TECHNICAL SURVEYS

The B.I.O. research and technical surveys program is summarized below.

4.1.1. Physical Oceanography

Arctic

Two major cruises were run in the Arctic this year. In June a large team from B.I.O., A.O.G. and I.O. Dal surveyed the Labrador Sea and the area northeast of Newfoundland with CSS "BAFFIN" and CNAV "SACKVILLE". Extensive oceanographic hydrographic, biological and chemical data were obtained. This work constituted Canada's contribution to an international survey around Greenland in 1963 arranged by ICNAF.

In September and October, a party from the Institute surveyed Baffin Bay, Smith Sound, Kennedy Channel, Kane Basin, and Hall Basin on CCGS "LABRADOR". This is the first time extensive work has been done in the channels north of Baffin Bay.

A compilation of all northern data has been started. At present Hudson Bay and Hudson Strait are being studied.

North Atlantic

Studies of the North Atlantic were continued this year with cruises of the CSS "BAFFIN" to the southeast of the Grand Banks and of the CNAV "SACKVILLE" to the southwest of the Banks. Both cruises were made in April-May. A considerable amount of data was collected over these areas which had previously not been extensively studied.

Gulf of St. Lawrence

Tidal survey and wave studies in the Gulf are outlined in other parts of the report. In November, a two-week cruise with B.I.O. and A.O.G. personnel on CNAV "SACKVILLE" was made to collect oceanographic information for this year's ice forecast by Ice Central and for continuing studies of the Gulf's oceanography.

4.1.2. Theoretical Studies

Wave Studies

Theoretical studies of wave length and wave height in the Gulf of St. Lawrence and Lake Superior have been completed. These have been used to establish a year-round relation between the waves and the climatological conditions based on five years' hindcasting data.

Currents

Theoretical studies are being carried out on the time-dependent motions in the ocean, in particular on some aspects of the transfer of energy from time-dependent atmospheric pressure systems (e.g. storms) to time-dependent motion in the sea.

Heat Transfer

Studies of the heat transfer in sea ice and its relation to movements of the ice-water interface have been undertaken in relation to the sea ice program.

Ice Physics

During the past year, attention has been directed to the study of heat flow problems connected with sea-ice formation and its removal using bubbler systems. Equipment has been purchased and constructed to perform a comprehensive experiment on these problems at Cambridge Bay during the period January - March 1964. An automatic data logging system will be utilized which records readings directly on to punched tape.

It is planned that the group working on these problems will move to Victoria, B.C. in April 1964 in order to work with a similar research group at the Pacific Naval Laboratory.

Air-Sea Interaction Studies.

The major activity has been the development of experimental equipment. A new model of the 3-component thrust anemometer has been built which is easier to adjust and service than the first model. It also enables heat and humidity sensors to be incorporated in the wind-sensing head.

A stable, taut wire, buoy with a superstructure containing a platform and mast to support measuring equipment has been built. It is currently being tested and it is hoped that it will provide a stable mounting for the anemometer, etc. in depths up to 50 fathoms. The platform and anemometer will be used off Aruba in January and February 1964 in a series of experiments on wind stress being conducted by B.I.O. in collaboration with WHOI.

A wind tunnel is under construction and almost complete. It has a 2-foot square working section and is operable with wind speeds from 0 to 60 m.p.h. Initially, it will be used for testing and calibrating instruments.

4.1.3. Marine Geology and Geophysics

Geological Studies

A number of projects have been undertaken around the East Coast.

The inshore waters of St. Margaret's and Mahone Bay were sampled for bottom fauna and sediments by means of scuba diving. Samples of bottom sediments were also taken from the Scotian Shelf, southeast of Halifax, from CNAV "SACKVILLE".

The Magdalen Shallows in the Gulf of St. Lawrence were sampled for bottom fauna and sediments in cooperation with F.R.B. Cores were also obtained in Malpeque Bay, P.E.I. in a cooperative program with F.R.B. Preliminary studies of the cores indicate excessive silting in this area.

In the Arctic a party on CCGS "LABRADOR" obtained cores, bottom samples, and submarine profiles during her cruise through Baffin Bay and the northern channels. In April and May, studies of fauna, sediments, and topography were made by helicopter northwest of Borden Island. In May and June, inshore work of the same type was done from motor toboggans off the east end of Borden Island. In July and August, cores were obtained from helicopter in the Prince Gustaf Adolph Sea.

In the laboratories, studies were made of the petrography of Exeter Bay in order to determine the contribution of ice rafting as contrasted with the normal increment from rivers.

Geophysical Studies

In marine geophysics, a joint operation with IODal was undertaken on the CCGS "LABRADOR" cruise. 5,000 miles of shipborne magnetometer records and 465 miles of sub-bottom reflection profiles were obtained. The magnetic records constitute the furthest north shipborne magnetometer measurements yet obtained. In October, a shipborne gravimeter test cruise over the Dominion Observatory test range south of Halifax was run. Two gravimeters were tested.

4.1.4. Hydrographic Surveys

The Hydrographic group at the Institute rose to 26 following transfers from Ottawa. It is expected to increase still further in 1964.

During 1963, the following projects were carried out:

CSS "BAFFIN" carried out charting in the Tail of the Banks area as recommended by the Fisheries Research Board from early June until mid-September.

CSS "ACADIA", in her fiftieth year of service carried out hydrographic projects in Great Bras D'Or, Cape Breton Island; Codroy, Lawn, Merescheen, St. John's Harbour, Flowers Cove, Baccalieu, Holyrood and Carmenville areas in Newfoundland.

CSS "KAPUSKASING" completed an off-shore survey between the Nova Scotia mainland and Sable Island for fisheries needs. She completed a project for the Department of Public Works in Miramichi Bay and spent considerable time calibrating the Decca navigation chains around the coast.

CSS "MAXWELL" carried out various urgent projects in the Gulf of St. Lawrence after completing a D.P.W. requested project at Dingwall, N.S.

Two shore parties were employed on continuing projects in Nova Scotia, one on the Eastern Shore and the other in the Cape Sable area.

Three surveyors were assigned to the D.O.T. ship CCGS "D'IBERVILLE" and one staff member sailed in CCGS "SIR JOHN A. MACDONALD". These northern parties had a relatively non-productive season due to the unusually heavy ice conditions in the North.

Proposals for the 1964 field season are as follows:

CSS "BAFFIN" will sail for the Caribbean on a combined oceanographic and hydrographic project. After she returns from the south early in May, she will carry out hydrography in the Bay of Fundy, Fisheries Area No. 4, as suggested by the Fisheries Research Board.

CSS "HUDSON" is scheduled to continue the Tail of the Banks survey during February, March and April. From July 1st to October 31st, she will be assigned to a project in Hudson Bay, which combines hydrography and geophysics.

CSS "KAPUSKASING" will be carrying out hydrography in the Chaleur Bay area at the request of the Department of Transport and the Department of Public Works.

CSS "ACADIA" will carry on her continuous hydrographic charting projects around Prince Edward Island and Newfoundland.

CSS "MAXWELL" will be assigned to the Gulf of St. Lawrence during the 1964 field season and will be carrying out chart revision surveys.

Our two shore-based survey parties will not operate this coming season due to shortage of hydrographers.

Tidal Survey

Personnel of the tidal survey group are now established at the Institute. From June to July, a current survey with MV "THETA" was carried out in the Pointe-des-Monts area. This was an extension of the previous season's work in the Gaspé Passage and was related in particular to the Gaspé Current. Intensive oceanographic observations were made in the area in cooperation with A.O.G. personnel and CNAV "SACKVILLE".

During August and September, the currents on a cross-section of Belle Isle Strait were measured. An E.M.F. cable was laid along this section to determine the mass transport through the section. The E.M.F. system has recorded continuously up until the present time. Oceanographic observations were taken during the survey.

Tide gauges were installed and operated in the areas of the two surveys.

In 1964 the group will be occupied in reducing the mass of data now on hand, and will also attempt their first deep ocean current meter moorings and measurements.

INVESTIGATOR SUMMARIES

4.2.1. Hydrographic Surveys

These reports cover the five establishments staffed by Hydrographers of the Bedford Institute of Oceanography. They do not include the parties on CSS "ACADIA" and CSS "BAFFIN" which were staffed from and reported to Ottawa.

The Kapuskasing Party under F. L. DeGrasse, with L. D. Quick as Senior Assistant, carried out a two-range Decca survey along the eastern shore of Nova Scotia. In addition; they completed a large scale survey in Miramichi Bay, N.B. and carried out extensive calibration of the Decca navigation chains in the Bay of Fundy, offshore Nova Scotia, and the Northumberland Strait areas.

The Maxwell Party, with P. L. Corkum in charge and S. S. Dunbrack as Senior Assistant, carried out a large scale standard survey of Dingwall Harbour, N.S., completed standard surveys at Baie Comeau, P.Q. and worked on various projects in the Gulf of St. Lawrence.

The Anderson Party, with T.B. Smith in charge and A. D. Kenney as Senior Assistant, carried on with her continuing survey projects in Cape Sable area of Nova Scotia, using the Hi-Fix electronic positioning equipment. Two minor projects in Port Medway and Lunenburg, N. S. were also completed.

The Eider Party, with R. C. Amero in charge and R. K. Williams as Senior Assistant, carried on with the continuing charting projects along the eastern shore of Nova Scotia and also carried out a reconnaissance survey in the Bras D'Or lakes.

The Eastern Arctic Patrol staff with J. M. R. Pilote in charge and A. L. Adams as Senior Assistant joined the D.O.T. vessels CCGS "D'IBERVILLE" and CCGS "SIR JOHN A MACDONALD" as planned, but their major projects in the North had to be cancelled due to extremely heavy ice conditions, since the escorting of supply vessels had overriding priority.

L. P. Murdock, R. M. Cameron and M. A. Hemphill were the first B.I.O. hydrographers to spend a field season at B.I.O. under the new rotation system. Mr. Murdock acted as Regional Hydrographer following the transfer of Mr. G. W. LaCroix to Ottawa in July. In addition to some minor surveys in the Halifax harbour area and aid to research staff whose projects involve hydrographic data or techniques, the rotation staff

set up a regional hydrographic data library for the filing of duplicate field sheets, computation records, tabulation sheets photographs and other field data. With a sharply increasing level of demand for information from local agencies it has been found essential that B.I.O. hydrographers have ready access to all field information for the regional area. This program has been greatly aided by the prompt provision of duplicate field sheets from headquarters.

Statistical Summary of Field Work - 1963

	<u>MAXWELL</u>	<u>KAPUSKASING</u>	<u>EASTERN ARCTIC PATROL</u>	<u>EIDER</u>	<u>ANDERSON</u>	<u>TOTAL</u>
N. miles sounded	818	7,682	-	636	1,084	10,220
Ship track sounding (n.miles)	-	-	11,619	-	-	11,619
Area surveyed (sq. n. miles)	40	2,441	-	8	201	2,690
Area triangulated (sq. n. miles)	35	51	-	-	47	133
Tellurometer traverse (n. miles)	74	61	-	-	-	135
Shoals examined	4	3	-	384	414	805
Coastlining n. miles)	37	-	-	19	26	82
Triangulation stations est.	74	32	-	29	58	193
Stations monumented	10	4	-	5	11	30
Conventional Decca Calibration stns.	-	132	-	-	-	132
Tide gauges established	4	3	-	5	6	18
Bench marks established	7	6	1	7	13	34

4.2.2. Air-Sea Interaction

L. A. E.Doe
S. D. Smith (until August)
J. A. Coombs (from October)

The major effort this year was devoted to the development and preparation of facilities for research in the field and in the laboratory. The first model of the three-component thrust anemometer has been modified and written up. A second model, similar to the first but using different transducers and circuitry, was constructed at B.I.O. A third model, incorporating significant changes, was designed by us and built by Eastbourne Engineering, Halifax, for New York University. A wind tunnel, which is a slightly modified copy of the one at Pacific Naval Laboratory, was built by Atlantic Bridge Company and is being used to test and calibrate the anemometers.

A "stable floating platform" was designed by the B.I.O. mechanical design section. It is intended for use in the trade wind area during January and February of 1964. If successful, a still larger one may be built for the Nova Scotian Shelf.

Preparation for the forthcoming joint operation with personnel of the Woods Hole Oceanographic Institution and New York University have taken most of the effort during the latter part of the year. This operation, to be undertaken by CSS "BAFFIN" in the vicinity of Aruba, N.A., during January and February 1964, will be our first major field operation and will serve both to test new equipment and to obtain data on wind stress on the sea surface.

4.2.3. Arctic Oceanography

A, E. Collin
A. M. Holler

Two oceanographic cruises in arctic waters were carried out aboard B.I.O. ships during the summer of 1963. Scientists from the Institute participated in U.S. Navy oceanographic surveys in the Labrador Sea and the Norwegian Sea.

Work has been initiated on a full scale review and appraisal of existing arctic oceanographic information in an effort to evaluate the data collection and to define the requirement for additional arctic oceanographic observations

and research. An assessment of the arctic research program which has been carried out from D.O.T. icebreakers is being prepared in conjunction with the data summary.

All Canadian oceanographic data north of 55° north latitude have been assembled and charts of station positions for each cruise have been compiled. To indicate the total station distribution up to the present time, a cumulative chart showing all stations has been prepared. This chart shows that the greatest density of observations has been obtained in the eastern arctic, mainly in the Labrador Sea, Hudson Strait, Hudson Bay, Foxe Basin, Lancaster Sound and Baffin Bay. Data from the channels of the western sector are sparse, being completely absent in some areas. The total number of stations recorded in the area is close to 2,000 and the areas most intensely surveyed have 15 or more stations per degree square. Although most of the arctic surveys have been undertaken since 1950, there are data for Hudson Bay, Hudson Strait and the western Labrador Sea extending over a period of 30 years.

It is intended that on completion, the results of this study will be compiled in some type of atlas presentation.

Distribution diagrams of temperature, salinity, and dissolved oxygen in Baffin Bay and Hudson Bay are being compiled for forthcoming analytical reports on the oceanographic conditions in these waters.

1963 Cruises

Through the courtesy of the Marine Branch D.O.T., the CCGS "LABRADOR" was made available for oceanographic work in Baffin Bay in September and October. Due to the stranding of ice island Wh-5 in Kennedy Channel early in the year, unusual opportunities for oceanographic sampling developed in this area. Unfortunately, due to extraordinarily bad ice conditions the "LABRADOR" was kept on escort duty until the end of August with almost no opportunity for research work during this critical period, during which Wh-5 broke up and drifted south. The "LABRADOR" was made available for scientific work early in September at Thule and returned to Halifax on October 27 after completing a survey of Baffin Bay, Smith Sound, Kane Basin, and Jones Sound.

The reduction and checking of the "LABRADOR" data is now

complete and the cruise report is in press. In cooperation with the U.S.N.O.O., 24 oceanographic stations were occupied in Baffin Bay as part of the ice-potential program. The LABRADOR's cruise plan is shown in Figure 7.

ICNAF*

A major oceanographic cruise was carried out on CSS "BAFFIN" in the Labrador Sea and Davis Strait during the period May 21 to June 16, the ship being manned by A.O.G. and M. & T.S. staff. The purpose of this cruise was to carry out the second ICNAF survey of northwest Atlantic waters as agreed by Canada at the Copenhagen planning meeting in 1962.

The agreed ICNAF observational program was followed whenever practical. Biological collections and the customary oceanographic observations were undertaken in conjunction at many stations. Fifty oceanographic stations were occupied in the Labrador Sea, Davis Strait and Baffin Bay north of 57° north latitude, and continuous magnetic, bathymetric and sea surface temperature records were maintained throughout the cruise. Sub-surface water temperatures indicated the major boundary between the colder waters off the Baffin Island coast and the waters of fairly uniform temperature on the Greenland Shelf.

An oceanographic team from the Bedford Institute took part in the cruise of the USS "ATKA" in the Labrador Sea from May 16 to June 14. As planned, the program conducted aboard "ATKA" would have extended the area covered by the ICNAF survey, but unfortunately, the "ATKA" was damaged by ice early in the cruise and was forced to abandon the survey after only 14 oceanographic stations in the western Labrador Sea.

4.2.4. Chemistry and Radio Chemistry

I. M. H. Pagden
A. R. Coote

Radio Chemistry

This program is intended to investigate the concentrations of fallout fission products in the oceans for purposes of studying their transport and also the mixing rates in the oceans.

* International Commission for the Northwest Atlantic Fisheries

The most useful radio isotopes have a high fission yield, long half life and interpretable marine chemistry. Strontium 90, Caesium 137, Cerium 144 and Promethium 147 satisfy the requirements most closely and have been the subject of reports by other workers. The latter two isotopes are not in wholly soluble form in sea water, which makes the interpretation of results more difficult.

Results obtained so far with our low background counter indicate that with the existing shielding material, it will be possible to produce the low background required for the beta counting in strontium assay, whilst the present gamma ray background is about an order of magnitude too great for measurement of the caesium activities expected. It is hoped that the shielding afforded by the 15 inches of iron of a hundred year old naval mortar, which has been loaned to B.I.O., will enable a satisfactory background to be reached.

Work is continuing on the design of a simple 100 litre water sampler, having a self-sealing lower cap, for use on the North Atlantic cruise next spring.

The analytical chemistry section was involved in chemical support work for several of the cruises during the past year and took part in the nutrient chemical analysis aboard CSS "BAFFIN" in connection with the ICNAF survey. This survey required a great effort to carry out the large number of analyses. Exclusive of oxygens and salinity determinations, some 2,500 nutrient analyses were completed. A good deal was learned on this cruise about the problems of carrying out chemical manipulations at sea. Good weather during the cruise allowed all station analyses to be completed. Nutrients analyzed for were phosphate, silicate, nitrate, nitrite, pH and alkalinity.

4.2.5. Current Surveys

W. I. Farquharson
R. C. Richards
D. Dobson
C. J. Langford

St. Lawrence Estuary - June and July 1963

A section across the mouth of St., Lawrence River from Pointe-des-Monts was surveyed to extend the investigation carried out in 1962 into the currents along a cross section of Gaspe Passage.

A fairly extensive survey of the surface currents at the mouth of St. Lawrence River had been carried out by the Hydrographic Service in 1933-34 and the data obtained summarized in "Tides, Tidal Streams and Currents in the Gulf of St. Lawrence". With the equipment available, it was not in those days feasible to obtain long period observations at individual stations, nor to obtain synoptic observations at several stations. The data then obtained indicated that it is in this area that the Gaspe Current reaches its full development; this seems to be due to the reinforcement which the seaward flow from St. Lawrence River receives from a near surface current which flows from the northern part of the estuary across the river entrance towards the Gaspe coast.

The purpose of the brief survey carried out in 1963 was to obtain a reasonably long period of synoptic observations of the flow, in the three distinctive water layers, along a section line with simultaneous oceanographic observations to provide data for an investigation into the mechanism whereby the Gaspe Current is formed.

This purpose seems to have been achieved but the analyses of the data are not in a sufficiently advanced stage for any final conclusions to be drawn. The records do, however, seem to confirm the existence of the transverse set.

Belle Isle Strait - August and September 1963

The flow through this strait has never been surveyed in detail and the data obtained during an investigation by Bell Dawson in 1912 did not yield any positive conclusions.

Originally, it was intended to carry out current observations across three section lines; a central line across the narrows, with the others about 10 miles on either side. Owing, however, to the presence of a large number of foreign draggers in the area, whose operations were a constant menace to the safety of the moored meters and hence to the probability of acquiring adequate synoptic data on any one section line, it was decided to concentrate on acquiring sufficient data on the line across the narrows.

In the immediate vicinity of this line, two cables were laid, one extending half way across the Strait and the other all the way, from Flowers Cove, Nfld. to Forteau Bay. These cables are used to measure the difference of potential created by the flow of water in the earth's magnetic field. The cables

give measurements of the overall flow through the Strait and of the flow through one half of it. This work was done in conjunction with the Atlantic Oceanographic Group Fisheries Research Board.

Tide gauges were installed at Belle Isle, at Boat Harbour, Nfld. and at Forteau Bay, while that originally installed by CSS "ACADIA" at Flowers Cove, Nfld. was taken over. The tide gauge at Forteau Bay was levelled to the bench mark installed in 1890, which was located after considerable search and through the recollections of the oldest inhabitant as to the sites of wharves in earlier days. Its recovery will eventually be valuable for the detection of the changes which may have occurred in the relative levels of land and sea.

Two series of detailed oceanographic observations were taken, the first covering a period of three days when ten runs were made across the Strait, whilst the second series was limited by adverse conditions.

A great deal of time during the course of the survey had to be devoted to sweeping for meters. All of the buoyant meters which were cut adrift from their moorings were eventually recovered but three of the non-buoyant type, which must be assumed to have been dragged from their original mooring sites were lost. In view of the activities of the draggers and of the passage of many ships through this narrow strait, often under very poor visibility conditions, these losses can be regarded as commendably small.

The observations obtained in Belle Isle Strait have not yet been analyzed, but it is believed that comprehensive data have been acquired.

4.2.6. Deep Ocean Circulation

C. R. Mann
T. R. Foote
R. Reiniger*
A. B. Grant

Studies of the ocean waters off the East Coast of Canada were continued this year with a two ship cruise in April off the Tail of the Grand Banks. The track chart is shown in Figure 11.

* Educational Leave from September 1963

CNAV "SACKVILLE" ran a series of oceanographic stations to the southwest of the Grand Banks. The object was to verify the idea that Labrador Current water mixes with North Atlantic central water along isopycnal surfaces that slope down to the west from the Tail of the Banks, thus forming deep Slope water. This was not well demonstrated as the area was flooded with a large body of almost pure Labrador Current water.

CSS "BAFFIN" ran a series of sections to the southeast of the Grand Banks across the Gulf Stream. Due south of the Banks, the Gulf Stream was found flowing east. There was no evidence of the Slope Water Current (or North Atlantic Current) which has been observed at times between the Stream and the Banks. It is noteworthy that this current was not present at a time when the area to the west of the Banks was flooded with Labrador Current water. The Gulf Stream was followed southeast to 40°W. longitude where it was still well defined and had turned south. There was no evidence of a strong branch turning north. Some branching may have occurred off the Tail of the Banks. South of the Gulf Stream, the surface waters to a depth of 400 m were uniform in temperature (~17.5°C.), salinity (~36.4%). North of the Stream, the temperature of the surface layer was 14°-16°C. There was no evidence of transfer of surface water across the current. One of the sections was extended north then west to the Grand Banks. The Labrador Current was crossed flowing south along the eastern edge of the Grand Banks. A strong, warm, northerly current was observed outside it. This has also appeared in similar sections made by other Institutes.

Some time was devoted to an examination of the parabolic program for interpolating oceanographic station data used by CODC. This type of interpolation is resulting in 'apparent' density inversions in interpolated data in the surface waters in the Slope water area. This work has been temporarily set aside as the staff member doing it is now on educational leave.

One further cruise is planned southeast of the Grand Banks in May and June 1964. The area immediately south of the Grand Banks will be examined in more detail to clarify whether the Gulf Stream does branch here, and to look at the area just south of the Stream where the oxygen content of the deep water was found to be lower than expected. The cruise will continue on across to the Azores for further examination of the oceanography of this area.

4.2.7. The Gulf of St. Lawrence

W. D. Forrester

A feature of the circulation in the Gulf of St. Lawrence that is being brought under careful scrutiny is the Gaspé Current, which flows seaward along the Gaspé coast. In November, an oceanographic cruise was conducted in the Gulf of St. Lawrence from CNAV "SACKVILLE". A paddle-wheel current meter was anchored in the Gaspé Current and a closely-spaced line of stations was observed across the Gaspé Passage to provide detailed profiles of temperature and salinity. It is hoped that this will provide evidence, based on the distribution of density, in keeping with the residual current pattern indicated in 1962 by direct current measurements. Since it took over half a day to complete observation of the section, a time sequence of observations was made over a tidal cycle on two stations in the Gaspé Current to determine how rapidly conditions varied in time, and hence to assess how justifiable it is to treat all the stations in the section as if they were observed simultaneously.

Twenty-three stations were occupied throughout the Gulf to provide the Sea Ice Central office of the Department of Transport with information necessary for their forecast of ice formation. At each of these stations temperatures and salinities were sampled at depths down to 250 metres, or to the bottom at shallower stations.

4.2.8. Environmental Prediction

C. D. Maunsell
W. B. Bailey
J. R. Lazier
R. H. Loucks*
J. Butters**

A knowledge of the marine environment is of great importance to people going to sea to earn a livelihood or for recreation. Part of the information needed has been supplied by various agencies for a considerable time in the forms of hydrographic charts and of marine weather forecasts. More recently it has become evident that fishermen and maritime defence forces can use information on the distribution of such oceanographic quantities as temperature, salinity and various nutrients. Data in the published literature is not

* On Secondment to Pacific Oceanographic Group, F.R.B.

** From November 1963

usually in a form where it can be used immediately and such historical data cannot be used by itself to predict day-to-day variations. Thus, it is necessary to have a service which can

- 1) extract from existing data probable conditions at some future season,
- 2) collect and plot current data so that short term predictions can be made.

These two aspects are analogous to provision of climatological data and to weather forecasting.

At the present time, the main contribution of B.I.O. in this field is the seconding of an oceanographer to head the East Coast Working Party on Oceanographic Services for Defence. Commencing in late November 1963, one technical assistant has been provided from B.I.O. but the rest of the technical assistance has been provided by the R.C.N.

At the Environmental Office in H.M.C. Dockyard, Halifax, information on surface temperatures and on structures observed on bathythermograms obtained in the Atlantic area of Canadian interest is received and plotted. Charts of surface temperature are transmitted by radio facsimile three times weekly. In addition, forecasts of probable conditions in proposed exercise areas are provided on request.

As time goes on, it is hoped to expand the environmental information service to provide services which may be better suited to the needs both of the defence services and of the fishermen. Neither class of user is finally interested in the temperature and chemical composition of the water. They are interested in how their quarry and the methods used to track it behave under various conditions. There is thus a wide field of research to be pursued in such fields as:

- 1) Models by which the distribution of quantities of interest can be predicted from the available data,
- 2) Presentation of the resulting information in such a manner that it is of maximum use to the potential user.

4.2.9. Frozen Sea Research

E. L. Lewis
P. H. Bridge*
J. A. Elliott**
J. Butters***
R. W. Mackay

In the past year, the group's attention has been directed to preparations for the study of the heat flow problems connected with ice formation and with bubbler ice removal systems.

During the first few months, a survey of existing literature was made and laboratories engaged on ice research were visited. These included the U.S. Army Cold Regions Research and Engineering Lab at Hanover, N.H. and the Ice Physics Group at McGill University. Purchase and construction of equipment for an experiment on heat flow through sea ice was begun in April 1963, and most of the heavy gear went north to Cambridge Bay, N.W.T. the location of the experiment by icebreaker during the summer.

The main objective of the arctic experimental program scheduled for January 1964 is to produce a reasonably accurate method for the quantitative prediction of the operation of bubbler ice removal systems. This end is to be sought by a combined experimental and theoretical attack. The anticipated experimental data may be analyzed in a variety of ways giving rise to two secondary objectives, investigations into the thermal properties of sea-ice and studies of the energy exchange between the frozen sea and the atmosphere.

4.2.10. Geology

B. R. Pelletier et al

During the spring and summer of 1963, the Marine Geology Unit of the Geological Survey of Canada under Dr. B. R. Pelletier transferred from Ottawa to the Bedford Institute of Oceanography. Marine geological laboratories were set up in sedimentology, micropalaeontology, X-Ray spectrography, X-Ray diffraction and organic geochemistry. At the same time, field parties prepared for research projects to be carried out in the Arctic Ocean, the Channels of the Arctic Archipelago the Scotian Shelf and the Gulf of St. Lawrence. Several field and

* From December 1963

** Educational Leave from September 1963

*** Until November 1963

laboratory projects commenced, and a few were completed by late fall.

D. E. Buckley completed his Master of Science research program on the bottom sediments of Lancaster Sound, District of Franklin. In addition he commenced and completed a field study on the bottom sediments in Malpeque Bay, Prince Edward Island, in cooperation with the Fisheries Research Board. The cores obtained on the project are now undergoing sedimentological, stratigraphic and geochemical analyses at the Bedford Institute.

D. R. Horn, presently on educational leave at the University of Texas, continued his research on the bottom sediments and submarine topography of Peary Channel and immediately adjacent areas in the District of Franklin.

L. H. King transferred in July 1963 to the Bedford Institute where he is organizing an analytical section in the organic geochemistry laboratory. He is presently developing a method for separating organic matter of a low ash content from the sediment. The area chosen for the investigation is on the Scotian Shelf in the vicinity of Emerald and Sambro Banks. A preliminary sampling program was carried out in August to provide samples for the development of a laboratory technique.

J. I. Marlowe completed his marine geological survey of the Prince Gustaf Adolf Sea, District of Franklin. He also assisted the Defence Research Board in obtaining bottom samples in the vicinity of Resolute Bay, District of Franklin, and has recently submitted a geological report on the samples to that agency.

B. R. Pelletier during the spring of 1963 continued a sampling program over the Arctic Continental Shelf adjacent to the western Queen Elizabeth Islands, District of Franklin. During September and early October, he headed an oceanographic and marine geology program in the arctic waters between north-western Greenland and Ellesmere Island, as well as in Jones Sound, in the District of Franklin.

G. Vilks commenced and completed a bottom sampling program in East Bay of Mackenzie King Island, District of Franklin. This is a continuing project involving a study of inshore sediments and microfauna from the floors of island channels. He is presently making routine identification of the fauna and noting the variation in population as the nature of the sea floor changes, or as certain oceanographic factors such as depth, temperature and salinity vary. He also commenced a study of bottom fauna and sediments in the Gulf of St. Lawrence in cooperation with the Fisheries Research Board.

G. A. Bartlett completed his Doctoral field research on a detailed study of bottom-dwelling foraminifera in various inshore, oceanic environments on the Scotian Shelf in the vicinity of St. Margaret's and Mahone Bays.

R. J. Leslie completed his Doctoral field-research on a detailed study of bottom topography, sediments, and fauna of Hudson Bay in the vicinity of the Churchill Estuary.

4.2.11. Geophysics

B. D. Loncarevic
P. H. McGrath
D. L. Barrett
P. Berghuis
G. Ewing*

The marine geophysics group was established in May and by the end of the year comprised four professional staff.

Two cruises were undertaken during the year as well as cooperation in four other field projects. On September 10, P. H. McGrath assumed from Dalhousie University responsibility for soundings, magnetometer and sub-bottom profiler ("boomer") on board CCGS "LABRADOR". The ship was working in the eastern arctic and reached 81°21'N., probably a record for a shipborne magnetometer. During the cruise, which ended on October 25 in Halifax, 5,990 line miles of magnetic data and 465 line miles of seismic profiling were collected. Very valuable experience was gained in operating geophysical equipment under Arctic conditions and in ice infested waters. One of the interesting results was a good boomer profile across Baffin Bay to Thule showing a relatively smooth sub-bottom without an indication of a median ridge.

The second cruise was in October on board CSS "BAFFIN". This was a shipborne gravimeter trials cruise. Two instruments were installed: an Askania GSS 2 and a LaCoste sea gravimeter. In addition an inertial navigation platform and extensive instrumentation for recording ship accelerations and motion were carried. The tests were carried out over the Dominion Observatory Sea Gravity Test Range, 50 miles south of Halifax, and consisted of 108 repeat passes along two selected profiles, some 30 miles in length. The Dominion Observatory, Gravity

* Education Leave from September 1963

Division, is analyzing the records of the LaCoste instrument. The preliminary analysis of Askania sea gravimeter records has been completed; the RMS difference between reference values and shipborne gravimeter readings is between 4 and 5 mgal. for most of the profiles. The calibration factor is suspect and will be checked in the spring; if an error of 1% is assumed, the RMS difference of only 2-3 mgal. is obtained and represents a probable limit of accuracy at the present time.

During the year instruments were lent to the Institute of Oceanography, Dalhousie University, and the Great Lakes Institute. D. L. Barrett assisted IODal in a seismic survey of Sable Island. A station magnetometer was operated at the Institute throughout the summer for diurnal correction of the shipborne magnetometer surveys of the Continental Shelf carried out by the Geophysics Branch of the Geological Survey on board CSS "BAFFIN" and CSS "KAPUSKASING". An attempt was made to operate a station magnetometer on Sable Island, but this experiment was not successful due to frequent failures of the equipment.

Dr. C. R. B. Lister of Washington, D.C. is developing for the Institute, a new temperature probe for heat flow measurements in the deep ocean. As a first step an eleven digit binary self-balancing bridge has been developed. At the Institute, a data reduction system has been designed for punching on tape data stored on FM multiplex magnetic tapes as a first step in the development of a universal data conversion system.

4.2.12. Instrumentation Development

R. L. G. Gilbert
N. S. Oakey

Wave Recording

It was hoped that some of the wave recording equipment of the accelerometer type could be tested and calibrated during the summer, and the Department of Transport made inquiries as to the feasibility of a wave recording program in the Gulf of St. Lawrence and Lake Superior. Several new accelerometers were built and tested, but due to delays in obtaining radio permits and in laying mooring buoys the equipment was not installed and the D.O.T. proposed program could not be started. An accelerometer buoy installed on the outer automatic buoy of Halifax harbour yielded inconclusive results, and it is hoped

to carry out calibration trials in the Caribbean during January and February of 1964.

A new wave recorder, which works well, was built and consists of a series of reed relay switches mounted at regular intervals inside an eight-foot long copper tube. A float carrying a magnet closes the switch closest to it and so the closed switch indicates the position of the float. One side of the switch is connected to a common line, whilst the other side is connected to a resistance chain, so that the wave height is proportional to the resistance measured across the output terminals. The copper tube has, of course to be mounted on a firm structure which is not affected by wave movement, and the recorder will be used on the stable platform in the Caribbean as a "standard" against which the accelerometer-type recorder will be calibrated.

Chart Digitizer

The early part of the year was spent in designing and building a device which would be able to convert strip chart records from their graphic analogue form to a digital form. This type of device was necessary if wave records were to be analyzed easily. Preliminary tests and measurements showed that the device would work and a "breadboard" model was constructed.

In the fall, a prototype was completed which can read records at the rate of 5 points/sec (and much faster with a faster digital recorder) and records the digitization on a Hewlett-Packard printer. It has an accuracy of plus or minus .5% f.s.d. The instrument digitizes records of the type suitable for ozalid reproduction.

A description of the equipment is to be submitted for publication in the near future.

Data Conversion Equipment

A start has been made on the design of equipment to convert data from the form in which it was recorded to a form suitable for feeding into a computer. One piece of equipment is described above, and a converter which accepts data recorded as an f.m. signal on magnetic tape and converts it to a digital punched paper tape has been built. Other equipment is needed to provide input and outputs on digital magnetic tape, punched cards, etc.

4.2.13. Theoretical Studies

G. T. Needler
K. O. Westphal
C. Quon
C. Ross*

With the arrival of C. Quon in March and G. T. Needler and K. O. Westphal in May, a group has been established at B.I.O. whose interests are primarily theoretical studies. This group intends to engage in basic theoretical studies as well as give assistance wherever feasible to other programs in the Institute.

Basic theoretical studies have been initiated for the purpose of gaining a better understanding of the large scale time-dependent motions of the ocean. At present, the free oscillations of the ocean are under study with special attention being given to the effects of a variable coriolis force and the spherical nature of the earth. In the future, effort will be directed to some of the problems related to the generation of time-dependent motions by moving atmospheric pressure systems and to those related to the inter-actions of different types of time-dependent motions with each other and the boundaries.

In order to supplement Dr. Lewis' experimental investigations of sea-ice, Dr. Westphal has undertaken theoretical studies on the formation and growth of sea-ice and on the performance of a bubbler system. He will also be involved directly in the analysis of experimental data. Details of this work may be found in Dr. Lewis' section of this report.

A wave hindcasting project, which was started in Ottawa in 1961 by Mr. Quon and which is based on five years' meteorological data for Lake Superior and the Gulf of St. Lawrence, has been completed. A detailed discussion of this work is available in BIO Report 63-2.

On the basis of this study, it has been found that in general, the waves in the Gulf of St. Lawrence are one and one-half times as high as those in Lake Superior and are of much longer wave length due to the intrusion of ocean swells. In addition, the waves of a height which occur only one percent of the time in Lake Superior occur at least five percent of the time in the Gulf of St. Lawrence and those which occur only five percent of the time in Lake Superior occur at least ten

* Educational leave from September 1963

percent of the time in the Gulf of St. Lawrence.

While the results obtained from the wave hindcasting in these regions can be taken as some indication of the wave heights to be expected through one year, it is felt that it is desirable to test the validity of the wave hindcasting methods used with wave records from the regions considered.

A preliminary study of spectral analysis methods for use on wave records and other geophysical data has been carried out and is now being applied to the reduction of gravity records.

5. AREA OF OPERATION DIAGRAMS

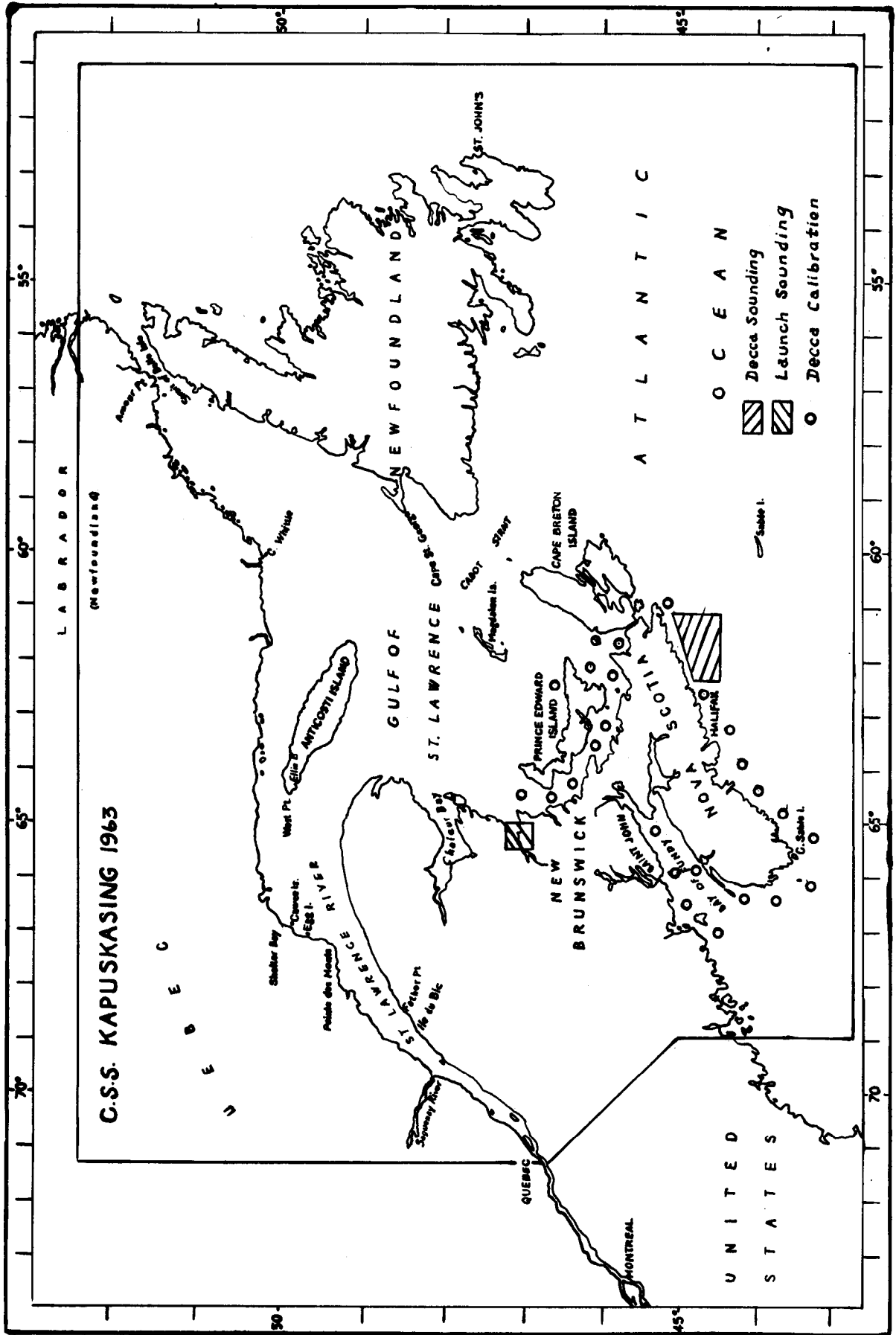


Figure 1.

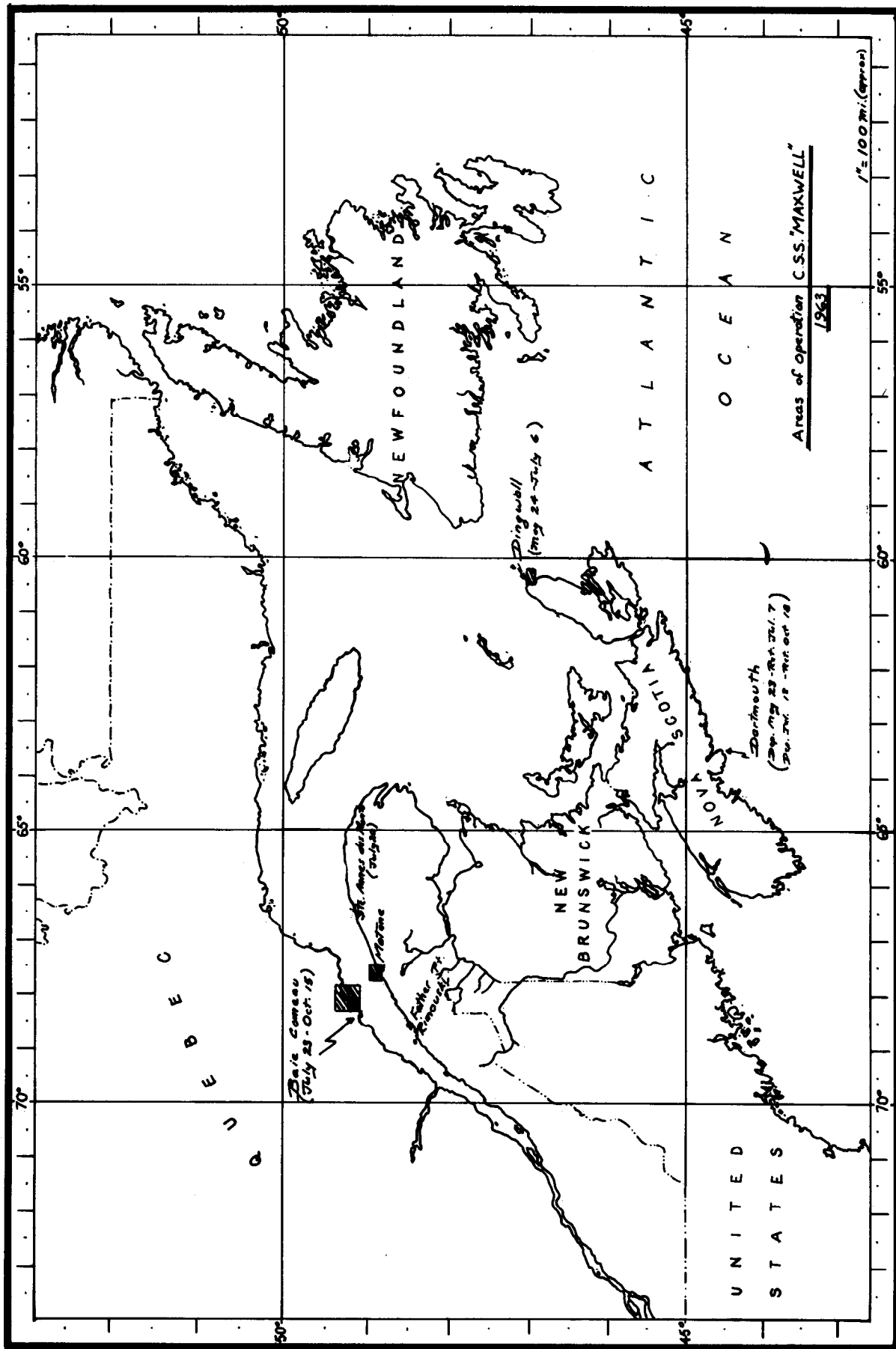


Figure 2.

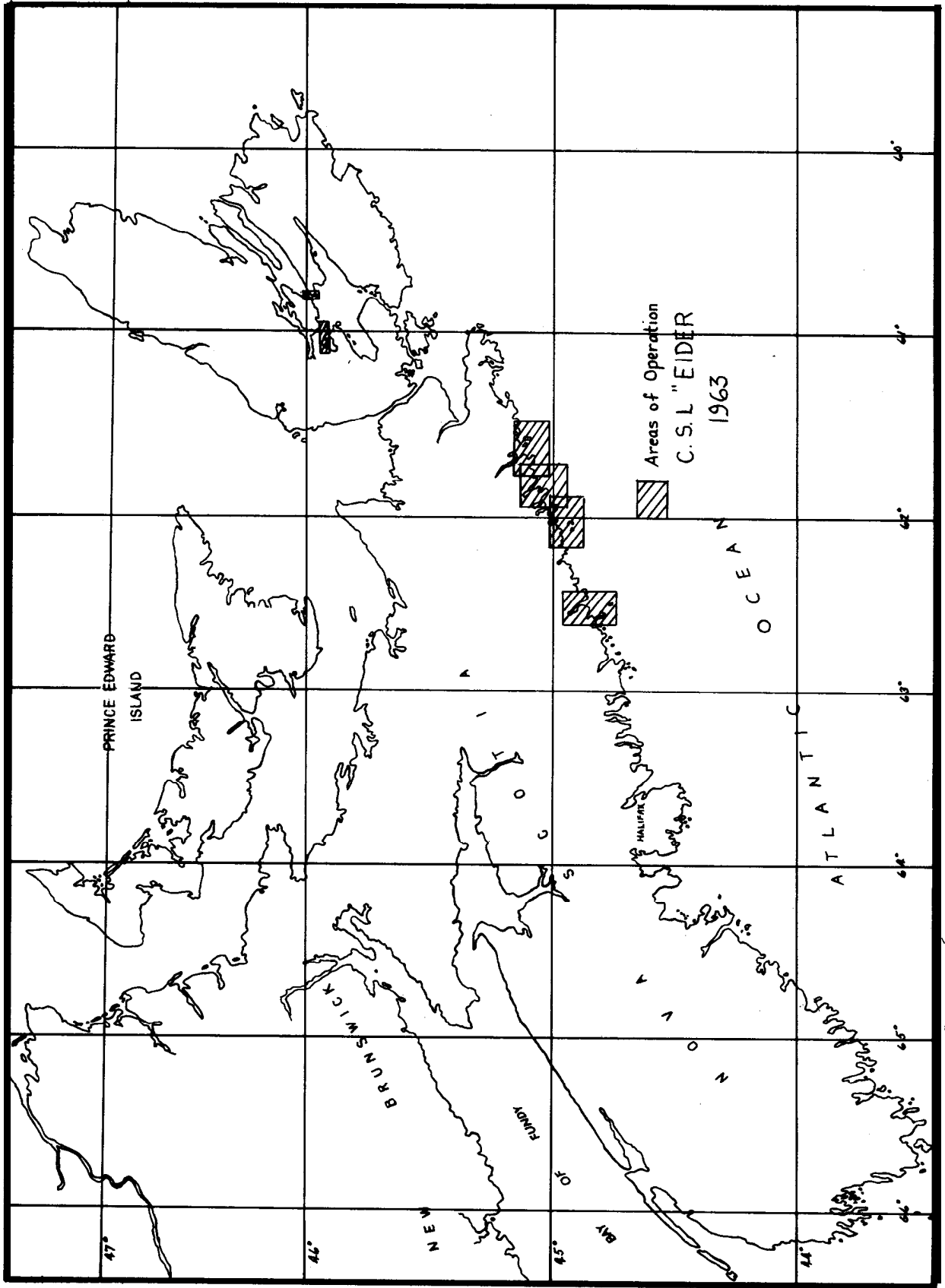


Figure 3.

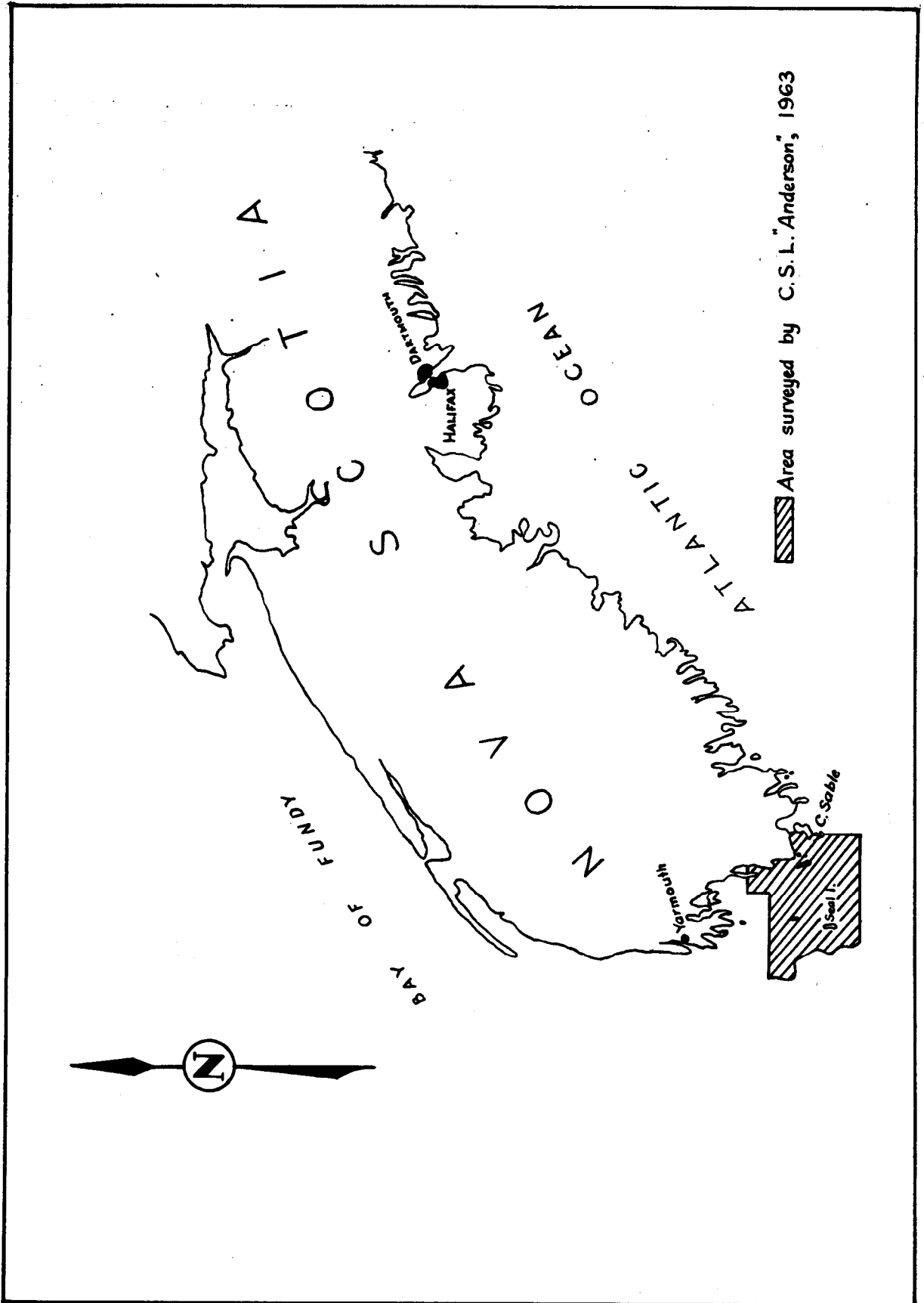


Figure 4.

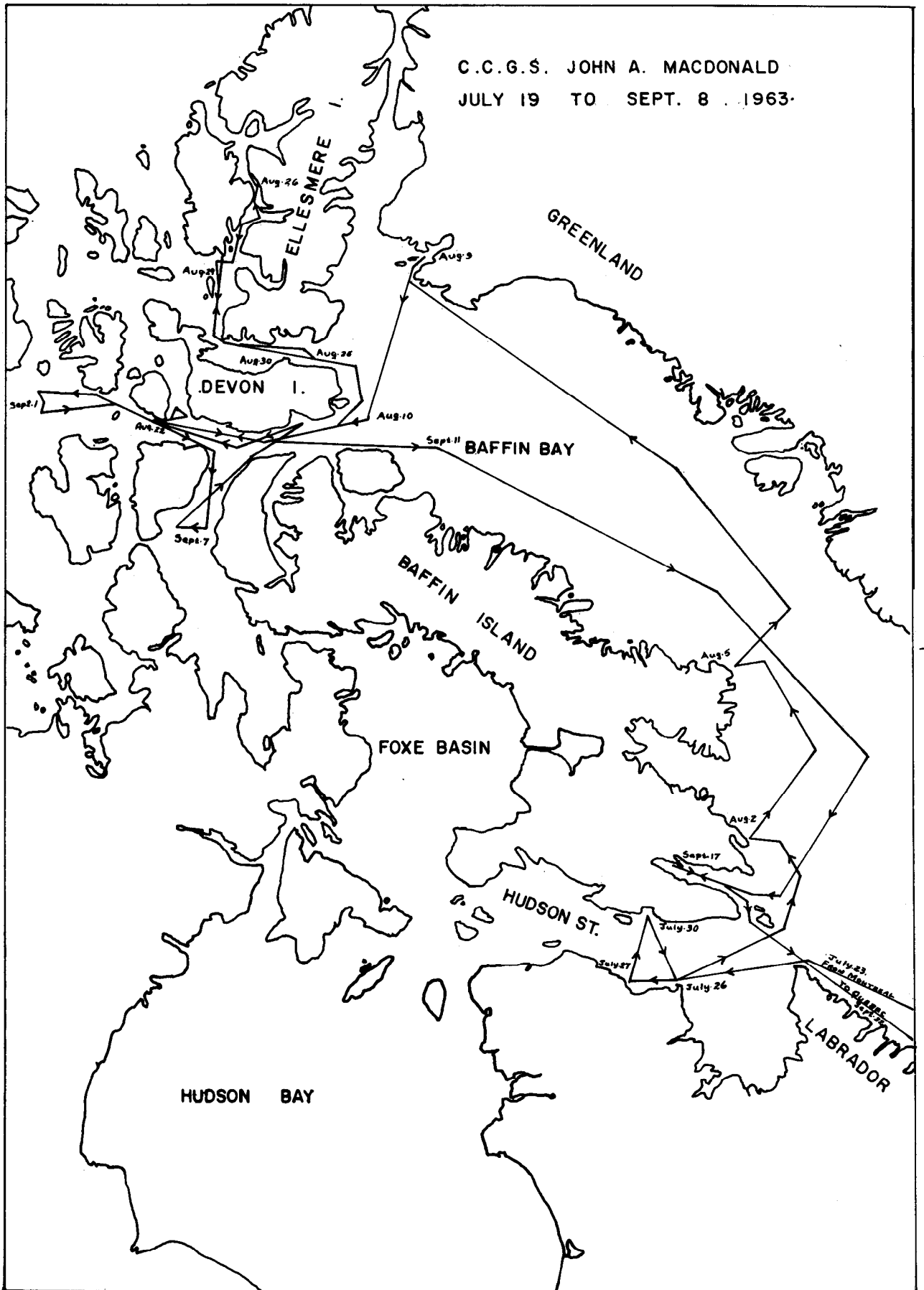


Figure 5.

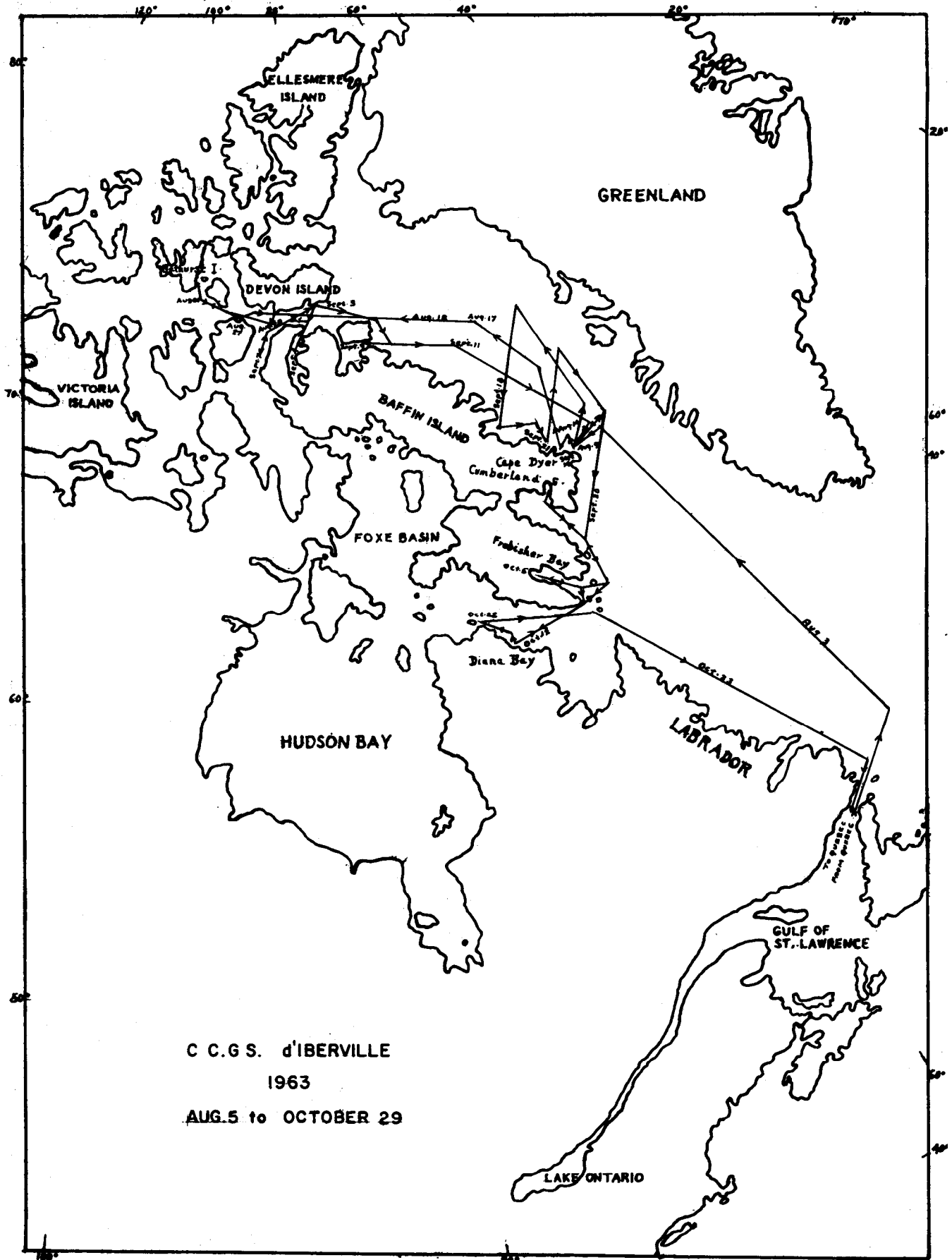


Figure 6.

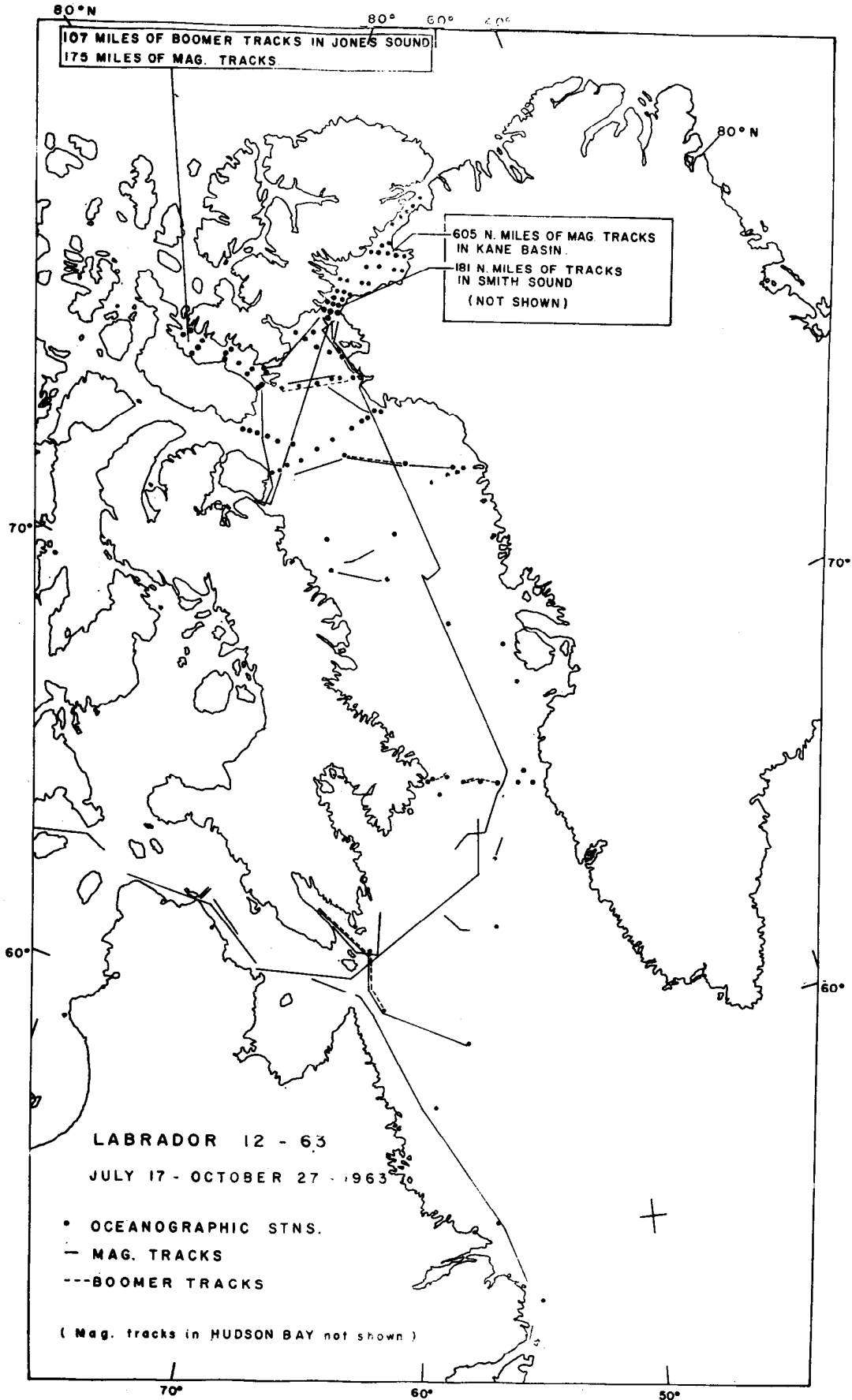


Figure 7.

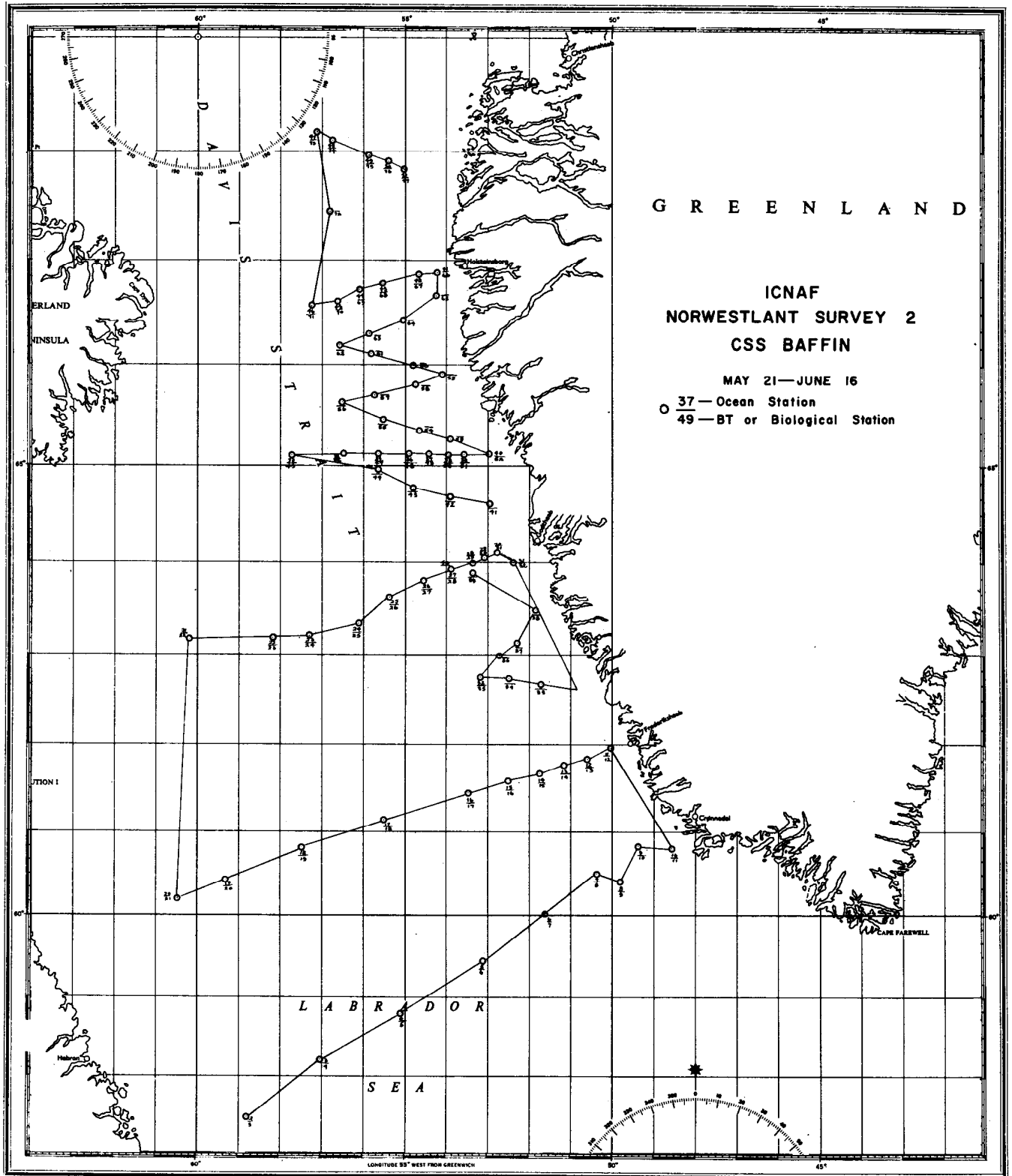


Figure 8.

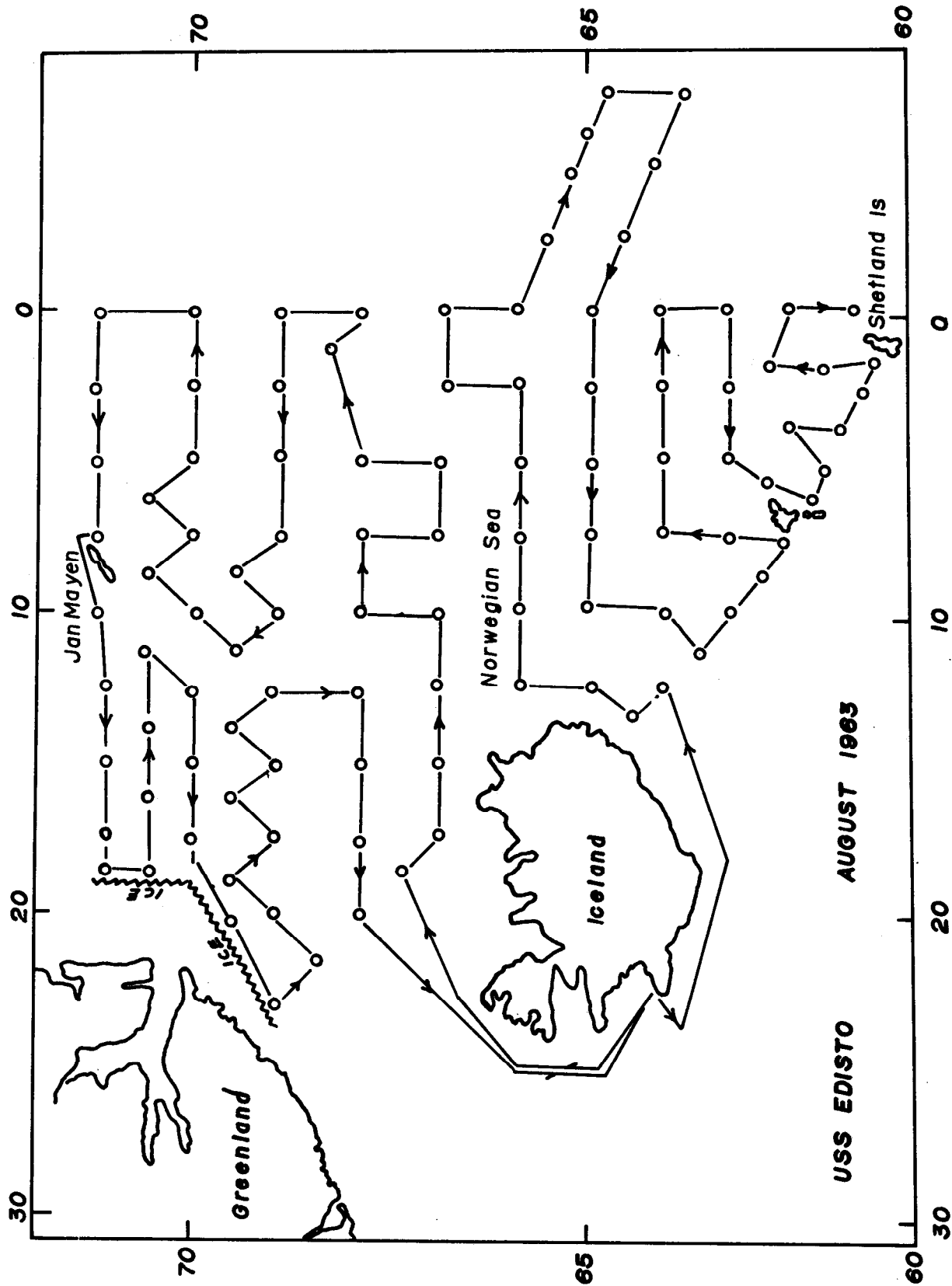


Figure 9.

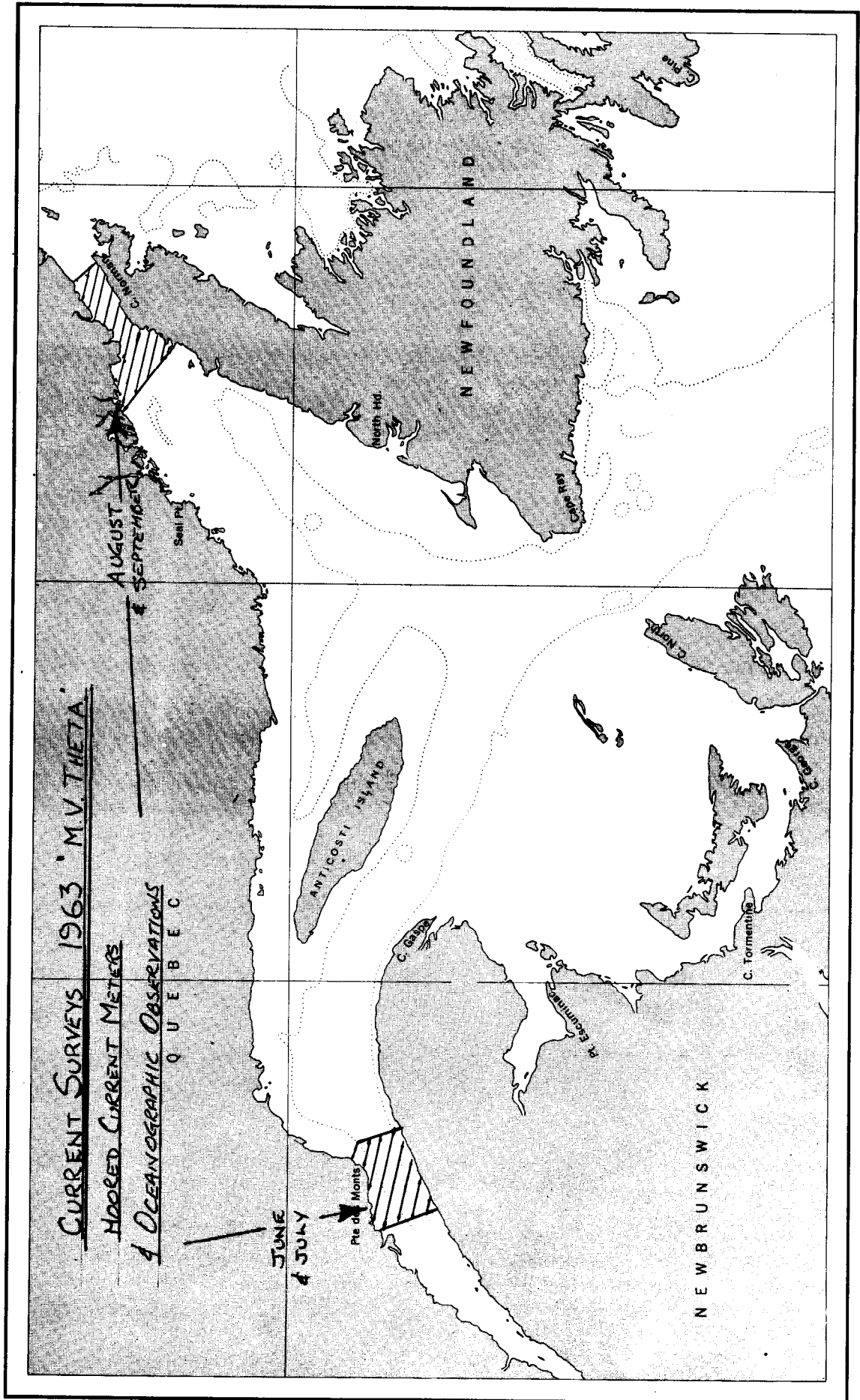


Figure 10.

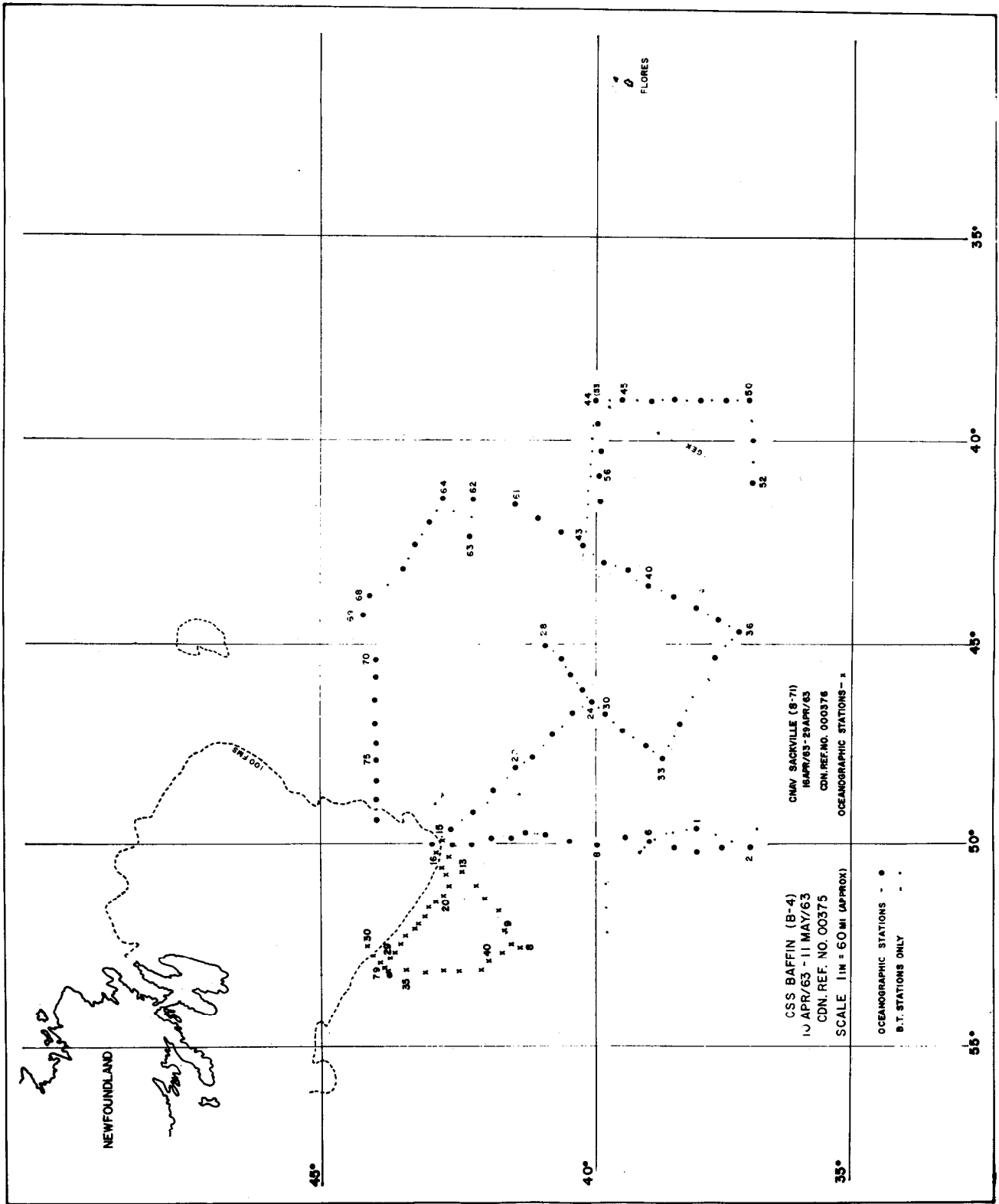
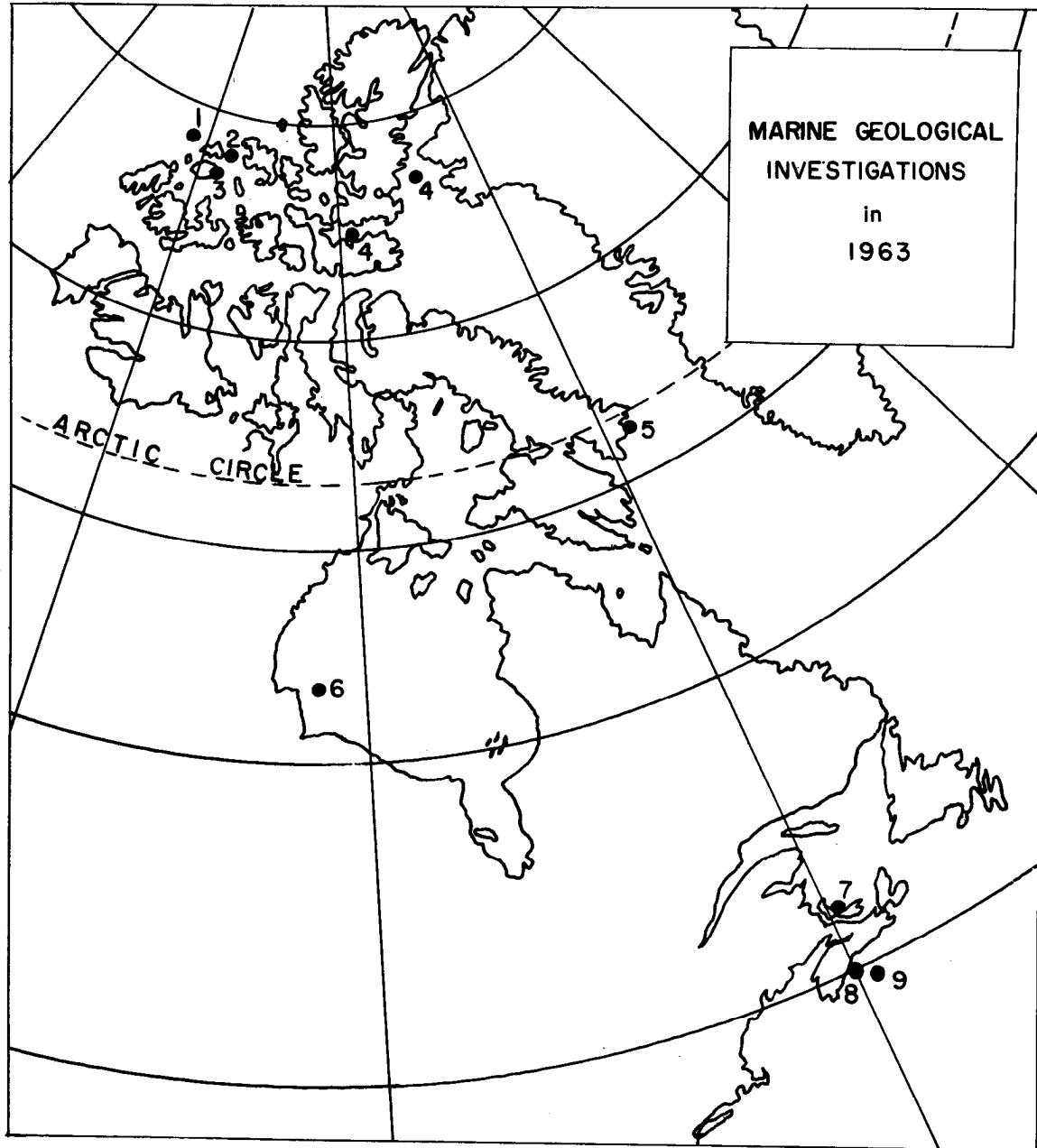


Figure 11.



- 1 B. R. Pelletier, Polar Continental Shelf
- 2 J. I. Marlowe, Prince Gustaf Adolf Sea
- 3 G. Vilks, East Bay, Mackenzie King I.
- 4 B. R. Pelletier, Jones Sound and Baffin Bay
- 5 K. Kranck, Exeter Bay, Baffin Island
- 6 R. J. Leslie, Churchill Estuary, Hudson Bay
- 7 D. E. Buckley, Malpeque Bay, P. E. I.
- 8 G. A. Bartlett, St. Margaret's and Mahone Bays
- 9 L. H. King, Scotian Shelf

Figure 12.

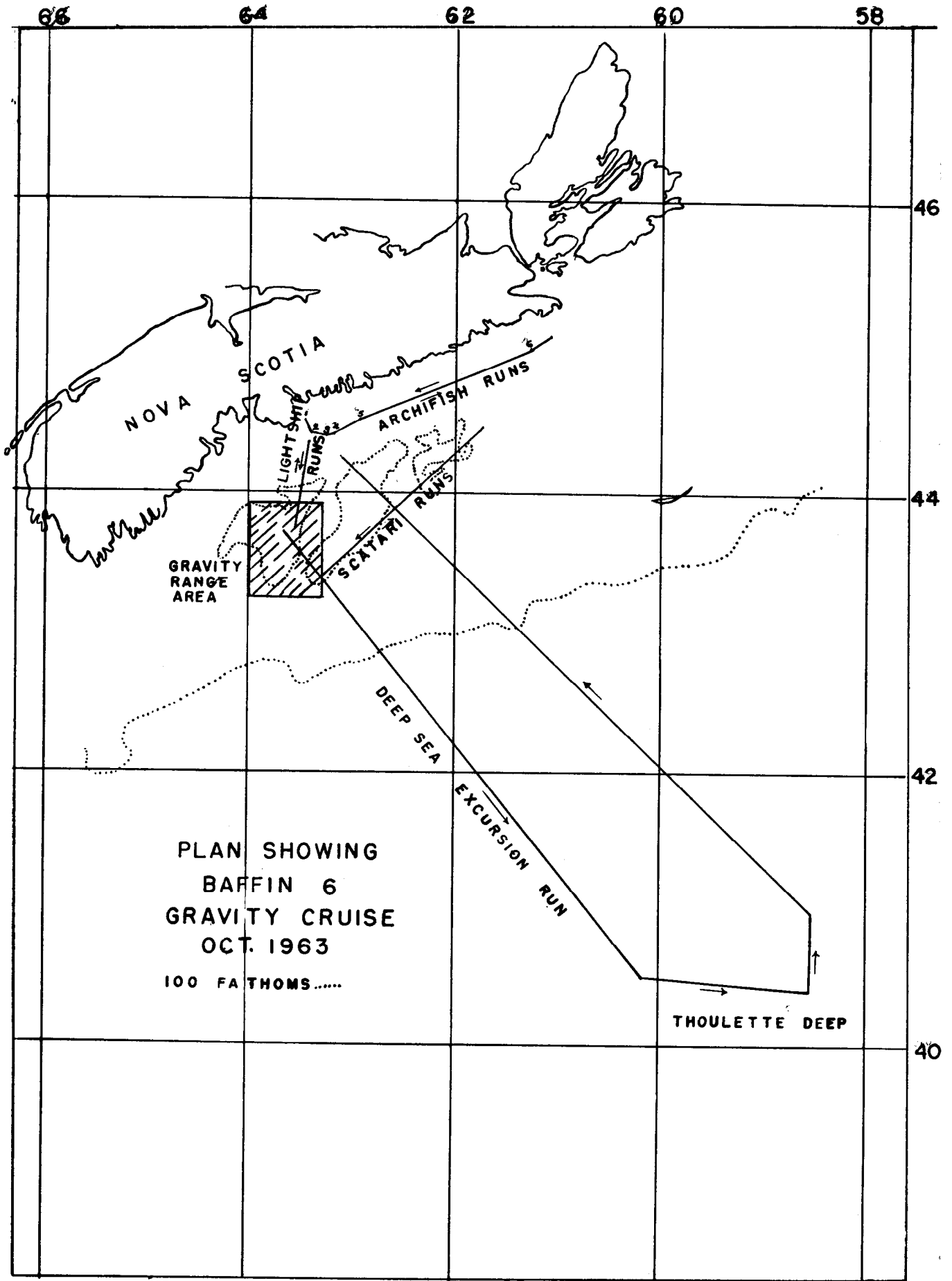


Figure 13.

6. PUBLICATIONS

6.1. B.I.O. Reports

- | | | |
|-------------|---|---|
| B.I.O. 63-1 | Doe, L. A. E. | A Three Component Thrust Anemometer for Studies of Vertical Transports Above the Sea Surface. |
| B.I.O. 63-2 | Quon, C.
Keyte, F. K. and
Pearson, A. | Comparison of Five Years" Hindcast Waves Statistics in the Gulf of St. Lawrence and Lake Superior.
December 1963. |
| B.I.O. 63-3 | Bartlett, G. A. | A Preliminary Study of Foraminifera Distribution in the Atlantic Continental Shelf, Southeastern Nova Scotia.
August 1963. |
| B.I.O. 63-4 | Leslie, R. J. | Sedimentology of Hudson Bay, District of Keewatin.
August 1963. |
| B.I.O. Text | LaCroix, G. W. and
Murdock, L. P. | The Use and Evaluation of Hi-Fix in a Canadian Hydrographic Coastal Survey.
September 1963. |
| B.I.O. 63-6 | | Second Annual Report |

6.2. Other

1. Barrett, D. L., Berry, M., Blanchard, J. E., Keen, M. J. and McAllister, R. E.:
"Seismic Refraction Studies on the Nova Scotian Shelf" in Travaux Scientifiques de l'Association Internationale de Seismologie, 1964.
2. Loncarevic, B.D.: "Accuracy of Sea Gravity Surveys" in NATURE, 198, 23-24, April 6, 1963.

3. Loncarevic, B. D., and Matthews, D. H.: "Bathymetric, Magnetic and Gravity Investigations" (Indian Ocean Expedition 1961-62) Admiralty Marine Science Publication No. 4, Parts 1 and 2, London, 1963.
4. Loncarevic, B. D.: "Geophysical Studies in the Indian Ocean" in the ENDEAVOUR, 23, No. 38, 43-47.
5. Loncarevic, B.D.: "Restless Islands" (review of a book "Continental Drift" Ed. by S. K. Runcorn) in DISCOVERY, 24, No. 2, p. 41 (Feb. 1963).

7. DIRECTORY OF PROFESSIONAL AND SENIOR TECHNICAL STAFF AS AT
DECEMBER 1963:

W. N. English:	Director	B.A., British Columbia Ph.D., California
L. P. Murdock	A/Regional Hydrographer	
C. R. Mann	Regional Research Oceanographer	B.Sc., M.Sc., New Zealand Ph.D., British Columbia
R. L. G. Gilbert	Engineer-in-Charge	B.A., M.A., Ph.D., Cambridge
J. S. Horam	Regional Ships' Officer	Certificate, Eng. 1st Class, U.K., B.O.T.
S. H. Scott	Administrative Officer	
R. C. Amero		Certificate, Land Survey Institute, Provincial Land Surveyor, N.S.
W. B. Bailey		B.Sc., Acadia
R. Balfour		
D. L. Barrett		B.Sc., M.Sc., Dalhousie
P. J. Berghuis		B.Sc.Eng., New Brunswick Certificate, Master (F.G.)
H. R. Blandford		Certificate, Master (F.G.)
P. H. Bridge		B.A., M.A., Cambridge
J. Brooke		M.I.M.E.
J. Butters		Certificate, Master (F.G.)
R. M. Cameron		

A. E. Collin	B.A., M.Sc., Western Ontario Ph.D., McGill
A. R. Coote	B.A., British Columbia
J. A. Coombs	B.A.Sc., M.A., Toronto
P. L. Corkum	
D. Dobson	Certificate, Master (F.G.)
L. A. E. Doe	B.A., M.A., Toronto Ph.D., New York
F. L. DeGrasse	
S. S. Dunbrack	Certificate, Land Survey Institute, Provincial Land Surveyor, N. S.
J. A. Elliott*	B.Sc., Saskatchewan
W. I. Farquharson	M.Sc. (Hon.), Liverpool
W. D. Forrester	B.A., Toronto M.Sc., British Columbia
V. J. Gaudet	Certificate, Land Survey Institute, Provincial Land Surveyor, N. S.
J. J. G. Godin*	B.A., College de l'Assomption B.Sc., M.Sc., McGill M.A., Toronto
M. A. Hemphill	
A. M. Holler	Certificate, Master (F.G.)
A. D. Kenney	
C. J. Langford	Certificate, 1st Mate (F.G.)
J. R. N. Lazier	B.A., Toronto

* Educational Leave

B. D. Loncarevic	B.A.Sc., Toronto M.A., Ph.D., Cambridge
E. L. Lewis	B.Sc., M.Sc., Ph.D., London
C. S. Mason	B.Sc., M.Sc., Western Ontario Ph.D., Cambridge
C. D. Maunsell	B.A., M.A., British Columbia Ph.D., California
R. C. Melanson	Certificate, Land Survey Institute, Provincial Land Surveyor, N. S.
P. H. McGrath	B.Sc., M.Sc., Western Ontario
G. T. Needler	B.Sc., M.Sc., British Columbia Ph.D., McGill
N. S. Oakey	B.Sc., McGill M.Sc., Saskatchewan
I. M. H. Pagden	B.Sc., Exeter
J. M. R. Pilote	Certificate, 1st Mate (F.G.)
W. J. Probert	Certificate, Land Survey Institute, Provincial Land Surveyor, N. S.
L. D. Quick	Certificate, Master (F.G.)
C. Quon	B.Sc., M.Sc., Alberta
R. F. Reiniger*	B.Sc., Saskatchewan
R. C. Richards	B.Sc., British Columbia
C. K. Ross*	B.Sc., Toronto
H. Sandstrom*	B.A., M.A., Toronto

* Educational Leave

J. G. Shreenan

T. B. Smith

Certificate, Land Survey
Institute, Provincial
Land Surveyor, N. S.

S. D. Smith*

B.Eng. McGill

H. B. Sutherland

K. O. Westphal

B.Sc., Wureburg, Germany
M.A., Toronto
Ph.D., British Columbia

R. K. Williams

Educational Leave

PARTIAL DIRECTORY OF SHIPS OFFICERS

CSS "BAFFIN"

Master	W. N. Kettle	Master (H.T.), 2nd Mate (F.G.)
Chief Officer	A. R. Turnbull	Master (H.T.)
2nd Officer	J. M. Taylor	Master (H.T.)
Chief Engineer	M. H. Himmelman	2nd Class Motor
2nd Engineer	J. Whatley	2nd Class Motor

CSS "HUDSON"

Master	W. J. Vieau	Master (F.G.)
Chief Officer	P. M. Brick	Master (F.G.)
2nd Officer	M. J. Wagner	Master (F.G.)
Chief Engineer	S. J. Lambert	1st Class Diesel
2nd Engineer	W. Buchan	2nd Class Diesel

CSS "KAPUSKASING"

Master	W. Thorne	Master (H.T.)
Chief Officer	A. Porter	Master (H.T.)
2nd Officer	G. K. Zinck	350 Ton Master (H.T.)
Chief Engineer	R. Berntsen	1st Class Eng. Steam
2nd Engineer	E. C. Clarke	3rd Class Eng. Steam

CSS "ACADIA"

Master	J. W. C. Taylor	Master (H.T.)
Chief Officer	J. R. Gillis	Mate (H.T.)
2nd Officer	F. W. Sheppard	Mate (H.T.)
Chief Engineer	J. L. Lavoie	3rd Class Steam
2nd Engineer	J. W. Baker	3rd Class Steam

CSS "MAXWELL"

Master	S. Baggs	Master (H.T.)
Chief Engineer	E. Backman	3rd Class Diesel

a. SUMMARY OF PROJECTS 1963, ATLANTIC OCEANOGRAPHIC GROUP,
FISHERIES RESEARCH BOARD*

The Atlantic Oceanographic Group, located at the Bedford Institute of Oceanography is a division of the Fisheries Research Board's Biological Station, St. Andrews, N. B. It conducts research on the physics, chemistry, geology, and biology in waters of the Canadian Atlantic area. The Board's oceanographers study the ocean with a view to understanding and increasing our important marine food resources. The program as a whole is slanted towards problems concerning groundfish and other bottom-oriented fisheries but current physical and chemical studies also have a bearing on problems associated with the movements and distribution of fish eggs and larvae.

Physical Oceanography

The study of the circulation dynamics and driving forces in the Gulf of St. Lawrence is a continuing project. Field studies this year have been concentrated in the Pointe-des-Monts area and in the Strait of Belle Isle. These were undertaken in cooperation with the Tidal Currents Section of the Department of Mines and Technical Surveys with a view to establishing boundary conditions for mathematical modelling purposes and in addition to attempt to establish an inter-relationship between the field of mass and the field of flow in the Gulf of St. Lawrence. In conjunction with a literature study of circulation dynamics, an electrical analogue model for the calculation of wind-driven circulation in the Gulf of St. Lawrence is being developed, and will presently be in operation.

For the purpose of measuring volume transport by the EMF method, a cable was laid across the Strait of Belle Isle early in August. At the end of October this installation was still functioning. As a supplement to this record, temperature, salinity, and current data have been collected in the Strait of Belle Isle area.

An extensive literature survey has been carried out in the field of optical oceanography. Following this, measurements were made of the turbidity of the waters at the mouth of the St. Lawrence River. Later in the year, a recently purchased underwater camera was successfully put into operation in bottom studies in the Magdalen Shallows.

In response to requests for bottom temperature information in the Gulf of St. Lawrence, temperature data have been analyzed

* This summary is included for the convenience of readers, through the cooperation of F.R.B. authorities.

for "SACKVILLE" cruises over the last 12 years and averaged on a monthly basis.

Between February, 1962 and February, 1963, the Halifax Section was occupied eleven times. These observations together with those taken during the previous twelve years have been analyzed to enable one to establish the normal seasonal patterns of temperature, salinity, and density.

Geology and Geochemistry

The program over the past year has been devoted to a study of the chemical composition of the marine sediments in the Gulf of St. Lawrence. A study of the distribution of the carbonates in the sediments on a regional basis has been made and the results distributed in Manuscript form. This work is part of a more precise chemical study of the marine sediments. At the present time, some 40 quantitative analyses of the marine sediments have been made, and the analytical data for the discussion of the geochemistry of Al, Fe, Mn, Ti, Ca, Mg, and P are being examined. The results of this work are being incorporated into sedimentological studies of the Gulf. A program of lesser scope was initiated in the early spring on the skeletal composition of the hard parts of marine organisms. X-ray diffraction of some 10 specimens has been made. The results indicate that few species show any tendency to form mixed (calcite and aragonite) skeletons. Further studies are being made on a wide selection of shells provided by the Biological Station, St. Andrews, N. B.

Benthic Fauna Studies

Biological work was concentrated in the southwestern part of the Gulf of St. Lawrence. This area has been placed under joint study between the Group and several of the biological investigators at St. Andrews. The broad aim of the program is to determine its production and productive capacity. The work was closely coordinated with studies on food organisms of groundfish presently underway at the Biological Station, St. Andrews, N. B.

Benthic fauna samples taken during cruise S-67 have been sorted, identified, and weighed. The procedure for the determination of wet formalin weights was the same as that used for the Baffin-2 samples. The S-67 samples were taken from an area of homogeneous sand bottom in the SE Gulf of St. Lawrence.

Nine stations consisting of 10 samples each were done. The data have not yet been analyzed for any apparent trends and variations in community composition or distribution of the benthic species.

In September multiple sampling for benthic organisms was carried out at some of the groundfish fishing stations with the intention that the results of these samples and of the groundfish stomach examinations would be mutually complementary. These samples have not yet been sorted, identified, and weighed.

ICNAF and Chemical Oceanography

The Group was charged with the responsibility of coordinating and organizing the Canadian contribution to the ICNAF Norwestlant Surveys 1-3 which began in April 1963. Canada manned two oceanographic ships, CSS "BAFFIN" and CNAV "SACKVILLE". The Canadian ships occupied the area west of Greenland and the Labrador Sea during May and June. They carried out measurements of salinity, temperature, dissolved oxygen, nitrate, nitrite, phosphate, silicate, pH and alkalinity. Plankton hauls also were carried out. The operation was fairly successful although inclement weather and ice restricted some of the work. All the Canadian physical and chemical results have been worked up and were reported on at a preliminary meeting in Madrid, Spain. The biological data are being analyzed, studied, and reported on by the Arctic Unit of the Fisheries Research Board. It will be difficult to draw conclusions about the results of the Norwestlant Survey until more data from the other participating countries becomes available.

In the laboratory, work is presently progressing in the estimation of activity coefficients of major ions in sea water by means of specific ion electrodes.

Cruises

The oceanographic cruises of CNAV "SACKVILLE" are coordinated by the Oceanographer-in-Charge. During the year, eleven cruises were carried out by the ship. Four of these were the responsibility of the Group, four were shared with other organizations, and three were carried out independently of the Group. A.O.G. personnel participated in the ICNAF cruise of CSS "BAFFIN", the Oceanographic program in the Pointe-des-Monts area and the EMF installation across the Strait of Belle Isle aboard the M/V "THETA" and in a Gulf of St. Lawrence cruise of M/V "HARENGUS" to sample for benthic organisms.

Data Processing and the Oceanographic Atlas

The Canadian Oceanographic Data Centre processes all physical oceanographic data, providing the Group with interpolated data of temperature, salinity, oxygen, sigma-t, sound velocity, dynamic height, specific volume anomaly, and potential energy anomaly. The Group was responsible for coding and submitting data from eleven oceanographic cruises to CODC for processing.

The Oceanographic Atlas has been distributed to twenty agencies. Volume 1 contains 226 pages consisting of cruises S-1 to S-62. Volume 2 is in preparation.

Staff and Facilities

The establishment of the Group is comprised of eight professional (one vacancy at present), six technical and two administrative and clerical. Offices, laboratories, and storage space are provided by the Bedford Institute of Oceanography.