

Confidential

FISHERIES RESEARCH BOARD OF CANADA

**ATLANTIC OCEANOGRAPHIC GROUP
ST. ANDREWS, N.B.**

ANNUAL REPORT

and

INVESTIGATORS' SUMMARIES

1959-60

N. J. CAMPBELL, A/OCEANOGRAPHER-IN-CHARGE

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Atlantic Oceanographic Group

Annual Report, 1959-1960.

INTRODUCTION

The Atlantic Oceanographic Group of the Fisheries Research Board carries out oceanographic investigations in the coastal and offshore waters of the Canadian Arctic and North Atlantic Oceans. The programs, which are co-ordinated under the Canadian Committee on Oceanography, are designed to fulfill the needs of the co-operating organizations, but chiefly those of the Fisheries Research Board, the Royal Canadian Navy and Defence Research Board. Other items of program are concerned with furthering oceanographic interests with universities and co-operating government agencies.

Oceanographic research demands general, specific, and fundamental studies of the ocean environment and its dynamics. The investigations, therefore, must encompass the processes which maintain or modify oceanic conditions, whether within the ocean or at its boundaries, the surface, the bottom, and shore. It is only by means of such studies that an understanding of oceanic conditions can eventually be achieved.

The objectives of this Group are:

- (i) to study the ocean environment, and the processes affecting seasonal and long term changes.
- (ii) to provide oceanographic data and information in a useful form for fisheries and national

needs.

(iii) to forecast oceanographic conditions.

(iv) to further interest in oceanographic research.

Oceanography on the East Coast is well supported by many co-operating organizations. The Fisheries Research Board provides personnel, laboratories, office space, administrative facilities, and certain classes of equipment. The Royal Canadian Navy, the Fisheries Research Board, and the Department of Transport provide ships, equipment, manning, and operation of three principal research vessels, CNAV "Sackville", CGS "A. T. Cameron", and CGS "Labrador". The Defence Research Board provides specialized equipment and funds chiefly for use, or in conjunction, with the operation of CNAV "Sackville".

General Program

The oceanographic effort of the Group has, until recently, been heavily committed in field studies of the Arctic and Passamaquoddy regions. This aspect of the work has been terminated and efforts are now being made to complete the analysis of the data. A variety of studies have been completed and have been, or are being, reported on.

The long term seasonal field programs of the Scotian Shelf, Gulf of St. Lawrence, and Grand Banks have been gradually reduced in magnitude and extent since the seasonal conditions are now comparatively well-established. A network of monitoring stations and sections was evolved simultaneously with the field program to monitor water conditions. The information that is gathered from these stations has proved to be a reliable

indicator of water conditions.

The seasonal field study programs are now being focused on the offshore waters of the Scotian Shelf, North American Basin, and Labrador Sea, including the Labrador Coast and Greenland. This extensive program has required a critical review of ship capabilities and the Group's principal oceanographic ship, CNAV "Sackville", is being re-equipped and refitted for the program.

One of the most promising developments in the Group's activities has centred on the mud-water interface which is of extreme importance to the major fisheries on the East Coast. This program involves studies of the distribution of bottom temperature, salinity, currents, and sediments, and will shortly be expanded into the fields of optical and chemical oceanography.

The field work associated with these programs was based on the use of CNAV "Sackville", CGS "Labrador", and CGS "A. T. Cameron". Personnel from the Group participated in eleven oceanographic cruises.

Summer cruises covered the water areas of the Scotian Shelf, Laurentian Channel, Grand Banks, the North American Basin, Labrador Sea, and Greenland. Other seasonal cruises covered the Bay of Fundy, Gulf of Maine, Laurentian Channel, and Gulf of St. Lawrence.

Two geological cruises were undertaken in the Gulf of St. Lawrence, Scotian Shelf, and Grand Banks by CNAV "Sackville" with personnel from Carleton University and this Group participating. The program was initiated in an effort to support geological oceanography at Carleton University.

Other "Sackville" and "A. T. Cameron" cruises were combined research investigations involving biology, geology, fisheries, and physical oceanography. Personnel from this Group and the Biological Station, St. Andrews, participated in the cruises. The field investigations are being followed by laboratory studies that involve close co-operation between biologists and oceanographers.

The general oceanographic conditions of the coastal waters were, as usual, monitored from the regular coastal observing stations at St. Andrews, "Lurcher" Lightship, "Sambro" Lightship, Halifax Harbour, Entry Island, and Port Borden. Offshore coastal water conditions were monitored at frequent intervals at two key sections, one off Halifax and the other in Cabot Strait. Coastal and offshore data were also provided by the Biological Station at St. John's, Nfld.

A major item in the program of the Group is the maintenance of a library of oceanographic data. This library consists mainly of our own cruise data, but is augmented by the addition of oceanographic data from Canadian agencies, all of which are processed and indexed by the Group. Additional bathythermographic records are supplied, on an exchange basis, from United States agencies. The oceanographic data collected by all agencies within the area of interest are also added to the files. The value of these files cannot be over emphasised, the collected data now constituting an enviable asset of the Group.

Associated Programs

While the Group has been involved in its own program of

research and investigations, it has also been active in co-operating with other organizations in stimulating interest in the collection of oceanographic information.

A number of investigational programs carried out by the Fisheries Research Board's Biological Stations at St. Andrews, St. John's, and the Arctic Unit, Montreal, resulted in the collection of considerable oceanographic data. Associated programs of data collection undertaken by the Navy, Naval Research Establishment, Defence Research Northern Laboratory, Canadian Hydrographic Service, and Polar Continental Shelf Project were supported by the Group. The routine processing of most of these data was carried out by the Group. Equipment and personnel were also supplied to assist many of these programs.

Thirty-four ships from five different organizations were involved in data collections on the East Coast and in the Arctic.

A member of the staff was assigned to CGS "Labrador" for a Department of Mines and Technical Surveys sponsored oceanographic cruise to Hudson Strait and Hudson Bay. This Group equipped the expedition and processed the data.

Personnel from the Group joined four cruises of CGS "A. T. Cameron" to conduct oceanographic and geological observations in the Gulf of St. Lawrence and Scotian Shelf.

General Liaison

Liaison was maintained with all organizations, both U. S. and Canadian, having a common interest in oceanographic problems of the western North Atlantic. This liaison is particularly close

relative to fisheries and national defence. Data are exchanged with the U. S. Navy Hydrographic Office and the Woods Hole Oceanographic Institution. These include exchanges of data from the Grand Banks region with the International Ice Patrol.

Surface water temperatures from St. Andrews and Entry Island, P. Q. were supplied daily to the Meteorological Service of Canada.

Numerous inquiries, relative to oceanographic conditions in the Canadian Atlantic waters, were dealt with.

Summary of Research Investigations

Lowered water temperatures continue to be featured on the Atlantic Coast in a trend that is characteristic of the last decade. The cooling trend first observed in the surface temperatures along the Atlantic Seaboard is now known to be general for the deep waters at the entrance of the Bay of Fundy and the Scotian Shelf. The St. Andrews surface temperature variations have proved to be an excellent index for surface and deep water temperature variations in other areas.

Analyses of air and water temperature variations indicate the trend of water temperatures over the last 85 years. A warming period from at least the 1870's to the late 1890's was followed by a cooling period during the first decade of this century. The well-known warming period from the 1920's to the beginning of the 1950's is now being followed by a cooling period that has persisted for the last few years.

Accumulation of data from the deep waters of the Scotian Shelf and other areas during the last decade make possible an

analysis of seasonal temperature variations of the bottom waters at several points. The amplitude of the temperature variations depends on the stratification of the waters and on the depth of the bottom.

The 1959 temperature conditions at depth seem to be the result of long term cooling and also of intense chilling during the winter of 1958-1959. A very cold intermediate temperature layer was still persistent on the Scotian Shelf in October, 1959. The cold water layer in the Gulf of St. Lawrence was observed to cover a much larger area of the bottom than in previous years.

The surface temperature conditions in 1959 were observed to decrease, except in the Gulf of St. Lawrence, where abnormally high temperatures were reported during the latter half of the year.

Abnormal temperature and salinity conditions were observed in Northumberland Strait. High temperatures, high salinities and lack of normal stratification in 1959 provided conditions never before observed in relation to lobster larvae distribution.

A program of five seasonal surveys covering the Atlantic waters off Newfoundland was completed in the summer of 1959. Analyses of the data are currently in progress to unravel the seasonal conditions of these waters. It is quite apparent, however, that "mixed" seasonal conditions prevail over the Grand Banks throughout the year. Such conditions depend on the relative strength and movement of two main ocean currents and their offshoots, the Labrador Current and the Gulf Stream. Mixtures of water from the Labrador Current and Slope Waters intrude over the

Banks and intermixing of these waters gives rise to extreme variations of temperature and salinity. Autumn inshore surface temperatures can fall as low as 3.0°C while offshore temperatures can rise to 10.0° and 12.0°C on the Banks or 16.0°C in the Slope Water band southwest of the Banks. Winter conditions are typified by extremely low temperatures prevailing over most of the Banks while spring and summer conditions show a remarkable change as warm waters, originating from the Slope Water band and the Gulf Stream, move northward.

Some phases of the drift bottle program undertaken by the Passamaquoddy Bay program have been continued in 1959. The program is now jointly undertaken by the Biological Station, St. Andrews, the Atlantic Oceanographic Group, and the Woods Hole Oceanographic Institution. The release points include "Sambro" Lightship, "Lurcher Lightship, and SS "Princess Helene". Returns have varied from each station averaging about 8.5%. The recoveries from "Sambro" and "Lurcher" indicate a southwestward drift along the Nova Scotia coast with current offshoots into the Bay of Fundy in the summer and autumn. Winter recoveries were made in St. Mary's Bay and the Cape Cod area, indicating some tendencies of a winter flow into the Bay of Fundy from the main southward flow off the East Coast.

The "Princess Helene" release point is on the New Brunswick side of the Bay of Fundy, but heavy returns occur on the Nova Scotian side of the bay in autumn and winter. Spring and summer recoveries are mostly taken in the Quoddy Region and along the American Seaboard. The results tend to confirm the fact that the surface circulation in the Bay of Fundy is "open" in the summer

and "closed" in the winter.

Final reports covering the Passamaquoddy investigations were submitted to the International Joint Commission. The reports conclude three years of intensive investigations in the Passamaquoddy Region.

The proposed Passamaquoddy power project involves the construction of a series of dams across the mouth of Passamaquoddy and Cobscook Bays. Passamaquoddy Bay, the proposed high pool, will be filled near high water by 90 filling gates, and Cobscook Bay, the proposed low pool, will be emptied near low water by 70 emptying gates. Water will flow continuously from the high pool through a 30 turbine powerhouse. Tidal range will be reduced to approximately 4 feet and 8 feet in the high and low pools respectively.

The effects of the proposed installation on oceanographic conditions in the region were considered by means of mathematical models and studies of water conditions in other estuarial systems. These studies proved helpful in evaluating qualitatively the controlling factors that would alter oceanographic conditions in Passamaquoddy Bay.

Under the proposed scheme, it was concluded that currents within the impounded regions would differ markedly from their present state. This condition, with the resulting decrease in mixing, would give rise to a new environmental balance of temperature and salinity. The changes would be mostly confined to the surface layer where increased stratification and seasonal variations of temperature and salinity would occur.

Electromagnetic methods of measuring the flow of water were employed quite successfully in the Passamaquoddy program. It was clearly established that more than 60% of the intertidal flow into Passamaquoddy Bay took place through Western Passage. The residual flow, although not very pronounced, was, on the average, outward through Western Passage.

As part of the Arctic program, resulting from the surveys of HMCS "Labrador", two detailed reports were completed. The one dealt with the sediment distribution in Foxe Basin and the other with a general survey of sediments of the Eastern Arctic Archipelago. The reports are based on an analysis of 300 grab samples and 30 cores taken in Arctic waters. All of these samples have now been analysed for size fractions and mineral contents with further analyses being carried out in many cases for biological content, including foraminiferal identification.

A submarine geological program has been initiated in Atlantic waters and is included in the overall program of study of the mud-water interface. Areas of investigation are centred around several major fishing banks in the Gulf of St. Lawrence and on the Scotian Shelf. The immediate goal of the program is to establish the geological and oceanographic factors that are of importance to groundfish investigations. Biological studies of the samples are being made by investigators at the Biological Station, St. Andrews, N. B. Specialized studies of the foraminiferal content and geochemistry of cores taken in the Gulf of St. Lawrence, the Scotian Shelf and the Grand Banks, are being conducted by the Geology Department of Carleton University, Ottawa.

Relative to Eastern Arctic waters, efforts were directed to analyses of data collected in previous years. Specific attention was given to water conditions, bottom configuration, and currents in the Foxe Channel - Hudson Strait area. The presence of unusually cold high salinity water in Foxe Basin and Foxe Channel led to a detailed study of the origin and formation of the water. It is suggested that this type of water is formed during cold winters by the formation of frazil ice and the freezing out of fresh water on the tide flats.

Incidental Activities

The Group designed and submitted detailed drawings for the new quarters of AOG in Halifax. These quarters are being readied for occupancy by the end of this fiscal year. The Group also participated in preliminary discussions of the laboratory and office lay-out of the Bedford Institute of Oceanography.

Members of the staff prepared and submitted plans for an extensive oceanographic reconversion of CNAV "Sackville".

Dr. Lauzier delivered a paper at the International Oceanographic Congress held in New York, Aug. 31 - Sept. 12. Dr. Campbell attended the First International Symposium on Arctic Geology, Calgary, Alberta, Jan. 11 - Jan. 13, 1960.

The Group took an active part in the "Open House" of the Biological Station in the way of exhibits and talks to industry representatives.

Dr. Lauzier attended the "Open House" at Grande Rivière, Quebec.

Various members of the AOG staff contributed to courses given for Fisheries Officers, at the Biological Station, St. Andrews.

Dr. Lauzier represented AOG at the annual meeting of the "Working Group on Ice in Navigable Waters", sponsored by the Canadian Committee on Oceanography.

SEA OPERATIONS

<u>Survey</u>	<u>Period of Operation</u>	<u>Ship</u>
Pelagic: Bay of Fundy,	Jan. 16	
Gulf of Maine.	Jan. 31	CGS "A. T. Cameron"
Groundfish: Scotian	Feb. 22	
Shelf.	Mar. 6	CGS "A. T. Cameron"
Seasonal: Scotian Shelf,	Feb. 2	
Grand Banks.	Mar. 30	CNAV "Sackville"
Seasonal: Scotian Shelf,	May 29	
Grand Banks.	June 18	CNAV "Sackville"
Submarine geology: Gulf	July 1	
of St. Lawrence.	July 6	CNAV "Sackville"
Seasonal and deep sea:	July 25	
Scotian Shelf, Grand		
Banks, North American		
Basin, Labrador Sea.	Aug. 22	CNAV "Sackville"
Submarine geology and deep	Sept. 26	
sea: Scotian Shelf, Gulf		
of St. Lawrence.	Oct. 8	CNAV "Sackville"
Arctic: Hudson Bay,	Sept. 9	
Hudson Strait.	Oct. 14	CGS "Labrador"
Pelagic: Bay of Fundy,	Nov. 5	
Gulf of Maine.	Nov. 12	CNAV "Sackville"
Groundfish: Gulf of St.	Jan. 17	
Lawrence.	Jan. 25/60	CGS "A. T. Cameron"
Groundfish: Gulf of St.	Jan. 29/60	
Lawrence.	Feb. 7/60	CGS "A. T. Cameron"

PERSONNEL

During the year, several staff changes took place. The Group was deprived of the services of the Chief Oceanographer, who joined Headquarters staff in Ottawa. While in St. Andrews, the Chief Oceanographer also acted as Oceanographer-in-charge of the Atlantic Oceanographic Group. Mr. A. E. Collin completed his educational leave at McGill University in May, and was seconded to the Polar Continental Shelf Project of the Department of Mines and Technical Surveys.

The staff consisted of the following:

H. B. Hachey	Acting Oceanographer-in-charge (to June 30).
N. J. Campbell	Senior Scientist Acting Oceanographer-in-charge (from July 1).
L. M. Lauzier	Senior Scientist
W. B. Bailey	Associate Scientist
R. W. Trites	Associate Scientist
A. E. H. Collin	Associate Scientist (Educational leave to April 30, on secondment to DM & TS, May 1).
F. D. Forgeron	Assistant Scientist
J. R. Chevrier	Junior Scientist
J. G. Clark	Technician III
G. B. Taylor	Technician II
J. H. Hull	Technician I
C. C. Cunningham	Technician I
T. A. Grant	Asst. Tech. III

R. K. Robicheau	Asst. Tech. I (to Nov. 1)
Mrs. M. M. Irwin	Stenographer III (Secretary to Chief Oceanographer, to May 21).
Miss S. H. M. Chandler	Stenographer I (from Jan. 1, 1960).

Seasonal & Term

D. G. MacGregor	Senior Scientist (June 16 to Aug. 31)
K. E. Hooper	Associate Scientist (May 14 - Sept. 14)
M. E. MacLean	Junior Scientist (from Oct. 1)
R. D. Graham	Student Assistant (June 1 - Aug. 31)
J. E. Curtis	Student Assistant (June 1 - Sept. 4)
J. E. Sweeney	Student Assistant (May 19 - Sept. 15)
Miss Ruth Coates	Student Assistant (May 19 - Sept. 23)
V. Carson	Technician I, (Nov. 2/59 - Feb. 29/60)
Miss Jean Clinch	Stenographer II (Feb. 11 - Sept. 30)

PUBLICATIONS

The following papers have been published or submitted within the year:

Bailey, W. B. Canadian contribution to IGY Polar Front Survey, North Atlantic, 1957-1958. Rapports et Proces-Verbaux, Int. Council Expl. Sea. (Special IGY Volume in press).

Campbell, N. J. Canadian IGY Project "Deep Water Circulation", North Atlantic, 1958. Rapports et Proces-Verbaux. Int. Council Expl. Sea. (Special IGY Volume in press).

Campbell, N. J. An International Geophysical Year Project. Atlantic Prog. Rept., No. 72, pp. 33-36, September, 1959.

Campbell, N. J. The origin of cold high salinity water in Foxe Basin and Foxe Channel. Abstract First International Symposium on Arctic Geology. Canadian Oil and Gas Industries, December, 1959.

Chevrier, J. R. Drift bottle experiments in the Quoddy Region. Appendix I to the Report of the International Passamaquoddy Fisheries Board to the International Joint Commission, 12 pp. October, 1959.

Forgeron, F. D. Temperature and salinity in the Quoddy Region. Appendix I to the Report of the International Passamaquoddy Fisheries Board to the International Joint Commission, 21 pp. October, 1959.

Lauzier, L. M. Canadian serial temperatures and salinities relative to IGY sea level recording, North Atlantic, 1957-1958. Rapports et Proces-Verbaux. Int. Council Expl. Sea. (Special IGY Volume in press).

Lauzier, L. M. L'océanographie est-elle vraiment utile aux pêcheries? Actualités Marines (in press).

Lauzier, L. M. and N. J. Campbell. Comparison of some oceanographic features in the Labrador Sea and Davis Strait regions 1928-1935 and 1950-1955. Preprints International Oceanographic Congress, AAAS, Washington, pp.103-104, 1959.

Trites, R. W. An oceanographical and biological reconnaissance of Kennebecasis Bay and the Saint John River Estuary. Appendix I to the Report of the International Passamaquoddy Fisheries Board to the International Joint Commission, 17 pp. October, 1959.

Trites, R. W. Probable effects of proposed Passamaquoddy power project on oceanographic conditions. Appendix I to the Report of the International Passamaquoddy Fisheries Board to the International Joint Commission, 22 pp. October, 1959.

Trites, R. W. and D. G. MacGregor. Flow of water in the passages of Passamaquoddy Bay measured by the Electromagnetic Method. Appendix I to the Report of the International Passamaquoddy Fisheries Board to the International Joint Commission, 24 pp. October, 1959.

Manuscript Reports

The following manuscript reports have been distributed:
Atlantic Oceanographic Group. Temperature distribution on the Scotian Shelf from October, 1953, to November, 1956. MS Rept. Series Oceanographic and Limnological, No. 35. April, 1959.

Atlantic Oceanographic Group. Oceanographic observations in Northumberland Strait. M/V Theta, Aug. 14 - Sept. 20. Appendix D to Causeway Investigation Northumberland Strait Report on Tidal Survey, Surveys and Mapping Branch, Department of Mines and Technical Surveys, pp.135-137, June, 1959.

Atlantic Oceanographic Group. Temperature and salinity observations taken in conjunction with current measurements in Passamaquoddy Bay and the Bay of Fundy, 1957 and 1958. MS Rept. Series Oceanographic and Limnological, No. 57. December, 1959.

Bailey, W. B. Canadian contribution to IGY Polar Front Survey, North Atlantic, 1957-58. MS Rept. Series Oceanographic and Limnological, No. 41. May, 1959.

Bailey, W. B. and H. B. Hachey. Water conditions in the North Atlantic. MS Rept. Series Oceanographic and Limnological, No. 38 (Confidential) 11 pp. April, 1959.

Campbell, N. J. Some oceanographic features of northern Hudson Bay, Foxe Channel and Hudson Strait. MS Rept. Series Oceanographic and Limnological, No. 46, 29 pp. September, 1959.

Campbell, N. J. and L. M. Lauzier. Ice studies of the Atlantic Oceanographic Group. MS Rept. Series Oceanographic and Limnological, No. 60, 12 pp. March, 1960.

Collin, A. E. Canadian oceanographic activities on IGY Drift Station "Bravo" MS Rept. Series Oceanographic and Limnological, No. 33, 11 pp. May, 1959.

Cunningham, C. C. Track charts of oceanographic cruises 1947-1959. MS Rept. Series Oceanographic and Limnological, No. 53. September, 1959.

Forgeron, F. D. A preliminary study of Foxe Basin sediments.

MS Rept. Series Oceanographic and Limnological, No. 45,
16 pp. September, 1959.

Lauzier, L. M. Canadian serial temperatures and salinities

relative to IGY sea level recording, North Atlantic 1957-
1958. MS Rept. Series Oceanographic and Limnological, No. 42.
May, 1959.

Thesis submission:

Perry, R. B. A study of the marine sediments of the Canadian
Eastern Arctic Archipelago. Submitted to the Graduate
School of the Agricultural and Mechanical College of Texas,
College Station, Texas. January, 1959.

N. J. Campbell

N. J. Campbell.

A/Oceanographer-in-charge.

St. Andrews, N. B.,

March 31, 1960.

INVESTIGATORS' SUMMARIES OF RESEARCH

1. Observations at Monitoring Stations M. E. MacLean
and J. H. Hull
2. Long Term Temperature Variations, Surface Waters.. L. M. Lauzier
3. Long Term Temperature Variations, Deep Waters L. M. Lauzier
4. Seasonal Variations of Temperature of Bottom
Waters L. M. Lauzier
5. Temperature Conditions on the Scotian Shelf,
1959 L. M. Lauzier
6. Bay of Chaleur Surveys, 1959 L. M. Lauzier
7. Surface Water Temperatures in 1959 L. M. Lauzier
8. Temperature and Salinity Conditions in
Northumberland Strait L. M. Lauzier
9. Seasonal Surveys of Oceanographic Conditions
in Newfoundland Waters W. B. Bailey
10. Variations in the Thermal Structure of the
Labrador Current W. B. Bailey
11. Contrasting Wintertime Conditions in
Newfoundland Waters W. B. Bailey
12. Annual Variations of Temperature and
Salinity in the Grand Banks Region W. B. Bailey
13. Daily Drift Bottle Release Project J. R. Chevrier
and R. W. Trites
14. Drift Bottle Experiments in the Quoddy Region J. R. Chevrier
15. Probable Effects of Proposed Passamaquoddy Power
Project on Oceanographic Conditions R. W. Trites
16. An Oceanographical and Biological Reconnaissance
of Kennebecasis Bay and the Saint John River
Estuary R. W. Trites
17. Flow of Water in the Passages of Passamaquoddy
Bay Measured by Electromagnetic Methods R. W. Trites
and D. G.
MacGregor
18. Geological Oceanography in the Bay of Fundy and
Gulf of St. Lawrence F. D. Forgeron
19. A study of the Marine Sediments of the Canadian
Eastern Arctic Archipelago Richard B. Perry
and N. J.
Campbell

- 20. Geological Oceanography in the Gulf of St. Lawrence K. E. Hooper
- 21. Some Oceanographic Features of Northern Hudson Bay, Foxe Channel, and Hudson Strait N. J. Campbell
- 22. The Origin of Cold High Salinity Water in Foxe Basin and Foxe Channel N. J. Campbell
- 23. Groundfish Cruises L. M. Lauzier
- 24. Drift Pole Experiments L. M. Lauzier and J. G. Clark
- 25. Technical Services G. B. Taylor

- 7. Surface Water Temperatures in 1959 J. M. Lauzier
- 8. Temperature and Salinity Conditions in Newfoundland Strait J. M. Lauzier
- 9. Seasonal Surveys of Oceanographic Conditions in Newfoundland Waters W. B. Bailey
- 10. Variations in the Thermal Structure of the Labrador Current W. B. Bailey
- 11. Contrasting Wintering Conditions in Newfoundland Waters W. B. Bailey
- 12. Annual Variations of Temperature and Salinity in the Grand Banks Region W. B. Bailey
- 13. Drift Bottle Release Project J. R. Chevrier and R. W. Triffes
- 14. Drift Bottle Experiments in the Gully Region J. R. Chevrier
- 15. Probable Effects of Proposed Passamaquoddy Power Project on Oceanographic Conditions R. W. Triffes
- 16. An Oceanographic and Biological Reconnaissance of Kennedysia Bay and the Saint John River Estuary R. W. Triffes
- 17. Flow of Water in the Passages of Passamaquoddy Bay Measured by Electromagnetic Methods R. W. Triffes and D. G. Macgregor
- 18. Geological Oceanography in the Bay of Fundy and Gulf of St. Lawrence W. D. Ferguson
- 19. A Study of the Marine Sediments of the Canadian Eastern Arctic Archipelago Richard A. Beny and W. J. Campbell

Observations at Monitoring Stations

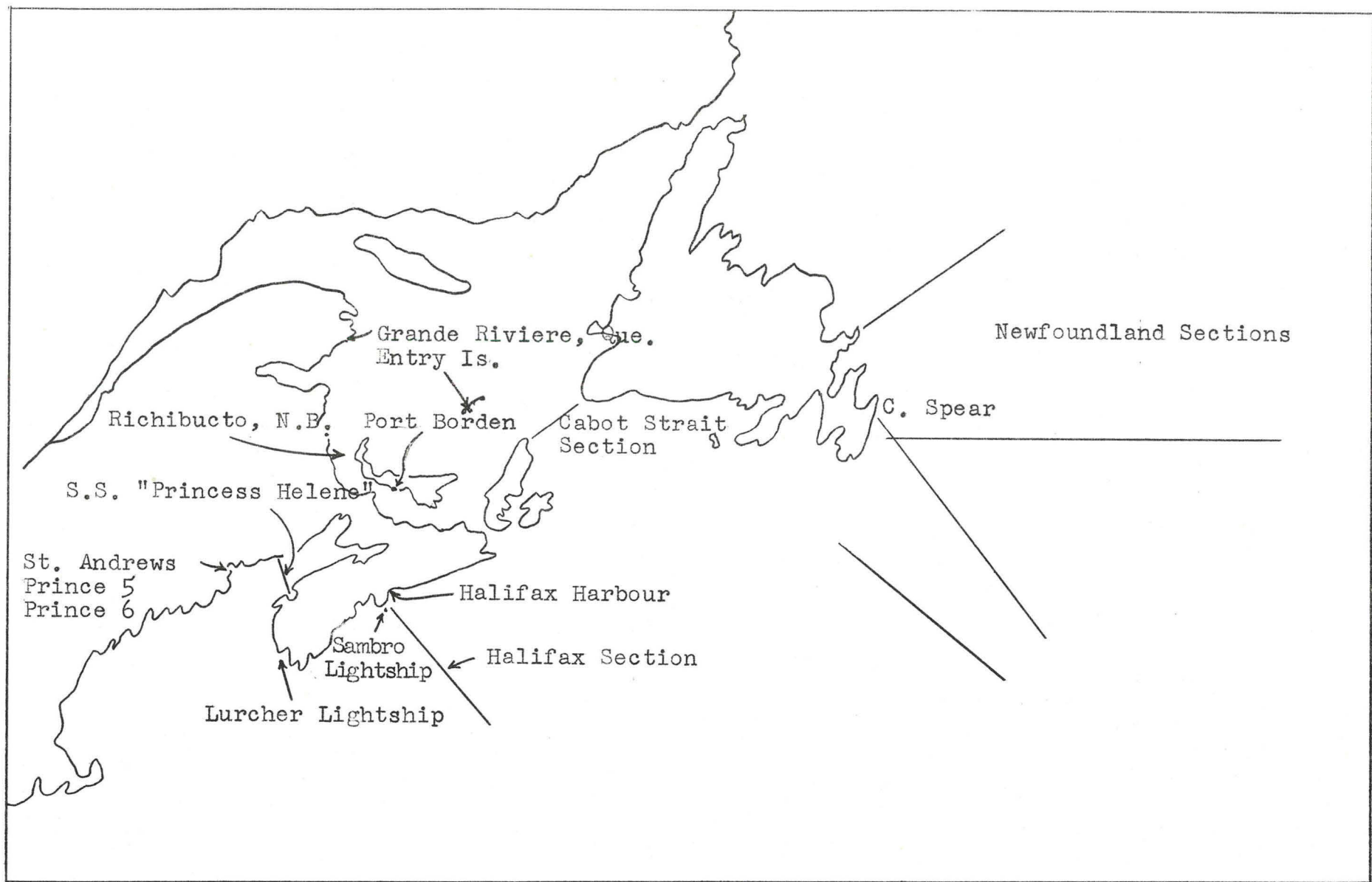
The Atlantic Oceanographic Group's data files comprise all available data gathered along the Canadian Atlantic coast by various participating agencies of the Canadian Committee on Oceanography. Data collected by other countries are also included in the files as they become available in publications.

One of the most important aspects of this library of data is the continuity of observations covering a period of years at various stations and sections.

The following is a summary list of the Canadian East coast stations or sections, inaugural date, sponsor, and types of continued monitored observations.

Prince 6, Passamaquoddy Bay.	(1916)	Biological Station, N. B.
Monthly observations of temperature and salinity at depth.		
Drift bottles.	(1957).	
St. Andrews, N. B.	(1921)	A.O.G.
Twice daily observations of surface temperature.		
Prince 5, Bay of Fundy.	(1924)	Biological Station, N. B.
Monthly observations of temperature and salinity at depth.		
Drift bottles.	(1959).	
Halifax Harbour.	(1926)	A.O.G.
Twice daily observations of surface temperature.		

- Entry Island, Que. (1926) A.O.G.
Twice daily observations of
surface temperature (except in
winter months).
- "Sambro" Lightship (1935) A.O.G. & N.R.E.
Twice daily observations of
surface temperature.
Twice daily BT casts. (1949)
Drift bottles (1959).
- Grande Rivière, Que. (1938) Station de Biologie
Daily observations of
surface temperature. marine.
- Cape Spear, Nfld. (1946) Biological Station, Nfld.
Fortnightly observations of
temperature and salinity at depth.
- Newfoundland Sections (1947-1950) A.O.G. and Biological
Quarterly to annual Station, Nfld.
observations of temperature
and salinity at depth.
- Richibucto, N. B. (1948) Biological Station, N. B.
Weekly observations of temperature
and salinity at three depths.
- "Lurcher" Lightship (1950) A.O.G.
Twice daily observations of surface
temperature, once daily bottom temperature.
Drift bottles (1957).



Monitoring Stations and Sections, East Coast.

Halifax Section (1950) A.O.G.

Quarterly observations of
temperature and salinity at depth.

Cabot Strait Section (1950) A.O.G.

Quarterly observations of
temperature and salinity at depth.

Port Borden, P.E.I. (1950) A.O.G.

Twice daily observations of
surface temperature.

"S.S. Princess Helene" (1958) Biological Station, N. B.

Daily drift bottle releases from
CPR ferry, Saint John to Digby.

M. E. MacLean

J. H. Hull

Long Term Temperature Variations, Surface Waters.

In the twenties, a program of surface water temperature observations along the Canadian Atlantic coast was initiated by the Biological Station at St. Andrews. The purpose of these observations was to study the seasonal and year-to-year variations of temperatures in various localities and also to follow the climatic variations. Twice daily observations of temperature were recorded at one time, from as many as fifteen coastal stations. After a number of years, only six coastal stations remained in operation, since duplicate results were being obtained.

The observations at St. Andrews, which began in 1921, are the basis of the longest continuous series of water temperatures in this part of the Atlantic Coast. Other series were started prior to this date, but they contain many interruptions. The data have been plotted in Fig. 1, Curve A, as a 10-year moving average, so that short period variations are eliminated. The St. Andrews curve shows an upward trend of the surface temperatures from the twenties to the fifties with a secondary maximum in the early thirties and a minimum in the late thirties. The rate of warming was greater in the forties than in the twenties and thirties. It seems that a reversal of the trend has been experienced in the last few years.

Such variations in temperature are not only typical of the waters of the Bay of Fundy area, they are closely related to the temperature variations of the waters on the Scotian Shelf, and those off Atlantic City, N. J. The reversal of the trend in the fifties is even more pronounced at "Sambro" Lightship and at

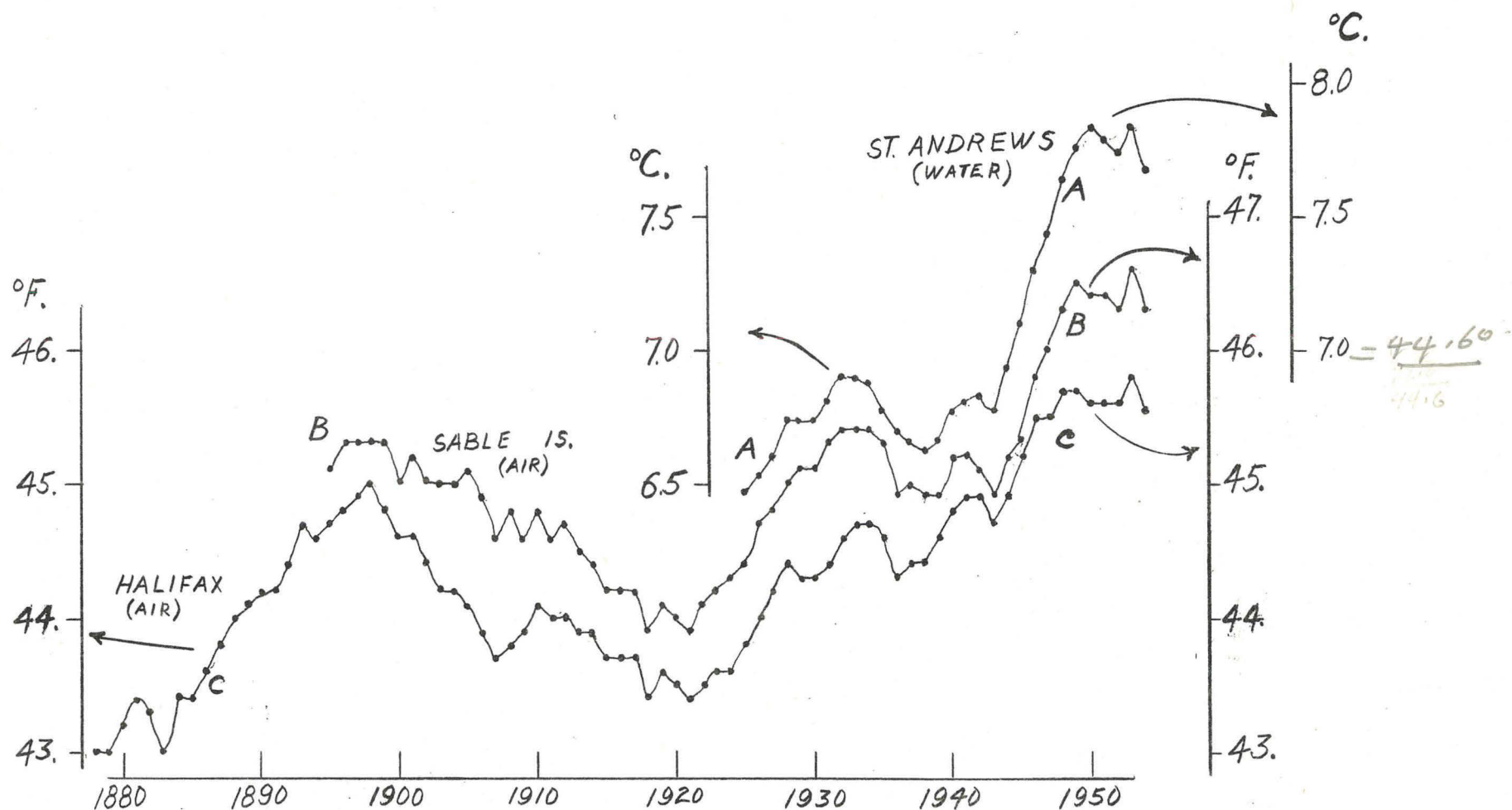


Fig. 1 Water temperatures at St. Andrews, N. B. (Centigrade) and air temperatures at Sable Island, N. S. and Halifax, N. S. (Fahrenheit): ten-year moving averages credited to the middle of each period.

Atlantic City than at St. Andrews, N. B. The temperature variations of the surface waters at St. Andrews are, therefore, representative of the variations along a large sector of the Atlantic Coast over the last four decades.

A comparison with air temperature variations from much longer records taken at Sable Island, N. S. and at Halifax, N. S., shows a close relationship between air and water temperatures for the period 1921 - 1959. Sable Island and Halifax data are shown respectively in curves B and C of Fig. 1, as 10-year moving averages. Because of the close relationship between the three curves for the last four decades, we are justified in extrapolating retrospectively. The longer air temperature records indicate what the trends of water temperatures were for the period prior to the establishment of the monitoring stations. A warming period, from at least the 1870's to the late 1890's, was followed by a cooling period during the first two decades of this century.

The Halifax air temperature curve suggests that the temperature variations over the last 85 years are partly periodic with a period of the order of 50 years and an amplitude of 2 to 2.5°F. The increase of temperature between two successive minima and two successive maxima indicates that the secular warming of the climate is of the order of 0.8°F per fifty years.

L. M. Lauzier.

Long Term Temperature Variations, Deep Waters.

The program of temperature observations at depth along the Canadian Atlantic Coast has been intensified in the post-war years. Seasonal cruises covering the entrance to the Bay of Fundy, the Scotian Shelf, and part of the Gulf of St. Lawrence were resumed in 1950. The coverage of the Scotian Shelf during the cruises was an extension of the pre-war coverage. In the Gulf of St. Lawrence, part of the Laurentian Channel and the Magdalen Shallows had the highest priority. From 1956, the frequency of cruises, as planned in 1950, was decreased because of other commitments but two sections were maintained for regular studies. The section off Halifax, towards Emerald Bank and the Continental Slope and the Cabot Strait section are now considered as part of a long range monitoring system. These sections are being carefully watched to establish and eventually forecast the seasonal and year-to-year changes over the Shelf and in the Gulf of St. Lawrence. The observations made regularly along those sections are the basis of a Scotian Gulf and Emerald Bank series and a Cabot Strait series. Additional observations were made at monitoring offshore stations--"Sambro" Lightship, "Lurcher" Lightship, and Prince 5.

A - Halifax Section

Bottom water temperatures for the coast have been monitored at "Sambro" Lightship off Halifax since 1949. This station has been maintained by the Naval Research Establishment, Dartmouth, N. S. During the period 1932 to 1939, observations

were made at frequent intervals at a station near "Sambro" Lightship during surveys of the coastal areas. The data are represented in curve A, Fig. 2, as quarterly deviations from the means. The temperatures during the period 1932 - 1939 are characterized by a general upward trend and during the period 1949 - 1959 by a general downward trend. The quarterly means in the thirties were, on the average, 1.6°C lower than those of the fifties.

In the Scotian Gulf, observations have been made during seasonal surveys from 1950 - 1959 as well as in the thirties. Temperature variations, curve B, Fig. 2, are those of the maximum temperature of the deep water layer in the Scotian Gulf. The actual temperature variations are shown since the seasonal temperature variations are very small in these waters as compared to those in somewhat shallower waters. The deep waters of the Scotian Gulf have been subjected to a general cooling in the fifties.

Over Emerald Bank, observations have been made during the seasonal surveys from 1950 - 1959 as well as in the early thirties. Data shown in curve C, Fig. 2, are deviations from monthly means. The bottom waters over Emerald Bank were cool in the thirties, they were relatively warm in 1951, but during the period 1952 - 1959, were characterized by a cooling trend as in the Scotian Gulf and the coastal areas. The temperatures over Emerald Bank were approximately 5°C lower in 1959 than in 1951.

B - Cabot Strait Section

For the last decade, the temperature variations of the deep layer of Laurentian Channel, as monitored at the Cabot Strait section, were not subjected to any warming or cooling trends. The

temperature of the core of the deep layer was high after the warming of the previous three decades. However, the waters at intermediate depths behaved differently. The temperatures of the waters of a salinity of 33⁰/oo at approximately 125 metres have been observed to decrease from 2.2⁰C in 1952 to 1.2⁰C in 1959.

C - Bay of Fundy Area

Temperature variations of the bottom waters in the Bay of Fundy area are shown by curves D and E of Fig. 2. Daily observations at "Lurcher" Lightship and monthly observations at station Prince 5 off the New Brunswick coast are the basis of these two series, plotted as 12-month moving averages. Both series show a cooling trend during the last decade, from a maximum in either 1951 or 1953 to a low value in 1959.

Summary

The deep water temperatures at the entrance to the Bay of Fundy and on the Scotian Shelf have been observed to decrease in the last decade from a maximum which occurred either in 1951 or 1953. The rate of cooling seems to vary from one area to another. It is interesting to note that the variations of surface temperatures at St. Andrews as seen in the 12-month moving average, curve F, Fig. 2, are reflecting the variations of deep water temperatures over a large area. The deep water temperatures in Cabot Strait are the exception.

The warming of the bottom waters of the Scotian Shelf, between the thirties and the beginning of the fifties have been reported by McLellan. There is evidence now that some of the conditions that existed during the thirties have been restored

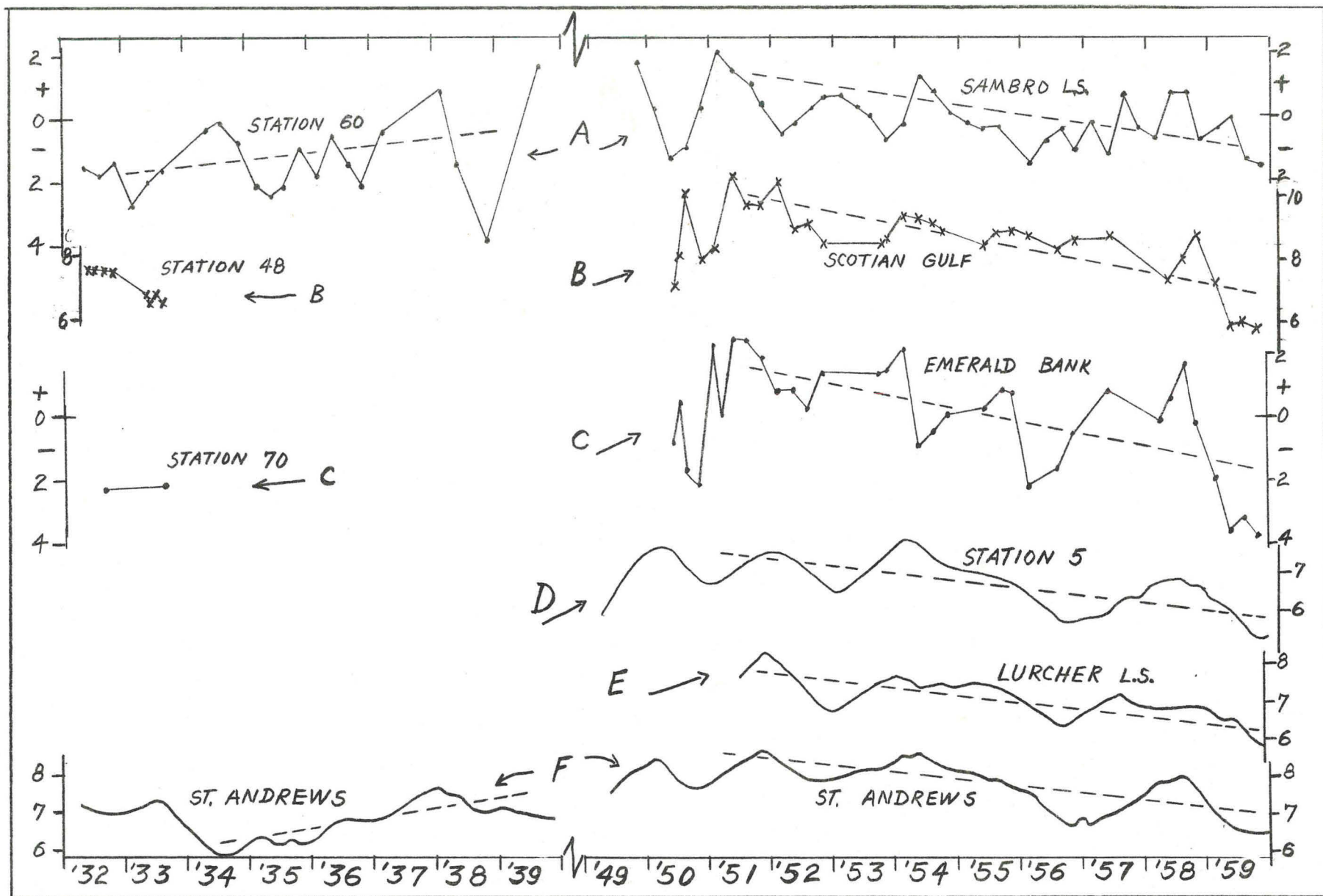


Fig. 2 Water temperature variations in the thirties and the fifties: deep waters, curves A to E; surface waters at St. Andrews, curve F. The trends are shown by dashed lines.

after the cooling reported above. Such changes in the environment have no doubt caused large fluctuations in the fisheries, especially with respect to groundfish. This problem will be investigated more fully in the coming year.

L. M. Lauzier

Seasonal Variations of Temperature of Bottom Waters.

Data pertaining to the characteristics of the bottom waters of the Scotian Shelf and other areas have been analyzed to determine the seasonal variations of temperature along the Halifax monitoring section and in the Bay of Fundy area. The data presented in the accompanying Table have been used by the author to calculate the seasonal or quarterly deviations of deep water temperatures in a study of long term temperature variations.

"Sambro" Lightship and "Prince" 60 station are located in the same vicinity off Halifax, N. S. and represent the coastal climatic conditions. The two series are listed to show the differences in the marine climate for the periods, 1932-1939 and 1949-1959. The "Prince" 5 station series covers only the period 1949-1959, while the complete records cover a thirty-five year period beginning in 1924. A previous analysis of "Prince" 5 data for the period 1924-1952 has been conducted by W. B. Bailey and others.

The annual amplitude of temperature variations depends on the stratification of the waters and on the depth of the bottom. On the Scotian Shelf, the bottom water at station 60 and "Sambro" Lightship is found in the intermediate cold water layer. On Emerald Bank and southwest Sable Island Bank, the bottom water is located in the upper reaches of the warm deep layer. The bottom waters of the Scotian Gulf, not represented in the Table, are well within the deep layer, with a very small amplitude of temperature

variations. Because of intense mixing in the Bay of Fundy area, the lack of stratification is shown by a large annual amplitude of temperature variations on the bottom.

L. M. Lauzier.

Monthly and Quarterly Averages of Temperature of Bottom Waters

	Sambro Lightship 1949-1959	Prince 60 Station 1932-1939	Emerald Bank 1950-1959	S.W.Sable Island Bank S. of Emerald R. 1950-1959	Lurcher Lightship 1950-1959	Station Prince 5 1949-1959
	(1)	(4)	(4)	(4)	(2)	(3)
January	4.3°C				6.1°C	5.7°C
February	3.7	1.7°C	8.0°C	7.7°C	4.4	3.5
March	2.4				3.8	2.8
April	2.3				4.0	3.3
May	2.5	1.3	5.9	6.2	5.2	4.2
June	2.7				6.5	6.0
July	3.2				7.7	7.7
August	3.5	1.9	6.0	6.4	8.9	8.9
September	3.6				9.8	10.4
October	4.4				10.2	10.5
November	4.7	3.8	6.3	6.4	9.7	9.9
December	5.0				8.2	7.8

(1) Twice daily observations

(3) Monthly observations

(2) Daily observations

(4) Cruise observations, Quarterly averages.

Temperature Conditions on the Scotian Shelf, 1959

As a continued series of observations, the section off Halifax, N. S. covering the Scotian Gulf, Emerald Bank, and the edges of the Scotian Shelf was monitored four times in 1959 between February and October.

In another summary, it was pointed out that the temperatures of the deep waters over the Scotian Shelf were observed to decrease during the fifties, although conditions in 1958 were almost normal. However, in 1959, temperatures were abnormally low for the three layers, surface, intermediate and bottom, wherever present.

In February, surface cooling was so intense that only two layers were present. A cold winter mixed layer that extended down to 60 or 70 metres or more, distributed the below-zero water to depths greater than 50 metres. The deep warm layer was separated from the mixed layer by a sharp temperature gradient. This layer (5.0 to 6.0°C) extended over Emerald Bank. The maximum temperature in the Scotian Gulf was 7.6°C .

In May, the surface layer temperatures were 8.0°C near the coast and only 6.0°C at the edge of the Continental Shelf. The intermediate temperature layer was widespread from the coast to the Continental Slopes. The lower edge of the intermediate layer with temperatures between 1.9 and 2.5°C covered Emerald Bank. The minimum temperature in the Scotian Gulf was 5.7°C .

In July, the surface layer, with an average thickness of 10 - 15 metres, attained temperatures of 12.0°C near the coast

and 16.0°C at the edge of the Scotian Shelf. The intermediate temperature layer had somewhat regressed and warmed since May, but it still covered Emerald Bank with temperatures between 2.5 and 3.0°C. The maximum temperature in the Scotian Gulf had increased to 6.0°C.

At the beginning of October, the surface layer reached a thickness of 20 - 30 metres with temperatures varying between 14.5 and 16.5°C. The intermediate temperature layer was still widespread but its thickness had decreased since July. However, it still covered Emerald Bank with temperatures between 1.0 and 3.0°C. The observed maximum temperatures in the Scotian Gulf was 6.1°C.

In 1959, temperature conditions, as observed in the section off Halifax, seem to be the result of long term cooling and also of intense cooling during the previous winter. Ice conditions over the northeast sector of the Scotian Shelf, as well as in the Gulf of St. Lawrence, were abnormally heavy in the winter of 1958 - 1959.

L. M. Lauzier.

Bay of Chaleur Surveys, 1959

In June-July, 1959, A.O.G. undertook a submarine geology survey of the Bay of Chaleur region. Oceanographic observations were also conducted in view of the previous winter of very intense cooling. The bottom temperature observations revealed a deep intrusion of the cold water layer into the Bay of Chaleur as far as the longitude of Bathurst, N. B. However, the below-zero water layer had only a thickness of approximately 25 metres. In the depression off Grand Riviere, Que., the bottom temperature was just above 0.0°C . To the south of the entrance to the Bay of Chaleur, between the New Brunswick coast and the north tip of Prince Edward Island and the Magdalen Islands, the cold water layer covered most of the bottom. Temperatures as low as -1.12°C were observed.

In September-October 1959, another submarine geology survey was undertaken particularly over experimental fishing grounds of interest to the Groundfish investigators of the Biological Station. Minimum observed bottom temperatures in the Bay of Chaleur were about 0.6°C . The cold water layer had regressed to the Laurentian Channel between 70 and 110 metres. The fact that the thermocline was deep at this time indicated that the range of bottom temperature was much greater than in July.

Temperature distributions during these two cruises were observed to be different from those of recent years as the result of the severe cooling of the previous winter, 1958-1959.

L. M. Lauzier

Surface Water Temperatures in 1959

Continued twice daily, surface temperature observations were taken at six shore or coastal stations in 1959. The observations of surface temperatures revealed a general decrease in all areas except one from the previous year. A decrease of temperature was experienced in the first six months of 1959, followed by a lesser decrease or an increase during the last half of the year. The general decrease in the first six months was the continuation of a general cooling trend observed in the latter part of 1958. The accompanying Table gives the monthly averages and the average monthly variations by six-month periods from 1958 to 1959 for the various stations in the Bay of Fundy area, the outer coast of Nova Scotia, and the southern Gulf of St. Lawrence.

In the Bay of Fundy area, the temperatures at St. Andrews and at "Lurcher" Lightship are shown to be below normal for most of the year. The St. Andrews annual temperature was 6.6°C as compared with the normal of 7.0°C ; it was also the lowest since 1948. The 1959 surface temperatures at "Lurcher" Lightship were the lowest for a period of 18 years.

On the outer coast of Nova Scotia, the surface water temperatures were, in general, below normal during the first six months of the year. They had a tendency to be above normal during the second half of the year.

In the southwestern Gulf of St. Lawrence, the surface water temperatures were apparently following a regime very different from that of the waters outside the Gulf. In eleven

months out of twelve, the temperatures at Port Borden were above normal and were observed to be much higher in 1959 than in 1958 during the second half of the year. This phenomenon was more pronounced in Northumberland Strait than around the Magdalen Islands.

The forecast for St. Andrews temperature last year was: "1959 will be a cold water year with an average temperature somewhat below the long term average of 7.0°C ". The average temperature was 6.6°C . It is now forecast that 1960 will be a mild year with an annual temperature in the vicinity of 7.5°C .

L. M. Lauzier

Monthly Surface Water Temperatures Along the

Canadian Atlantic Coast,

1959

	St. Andrews N.B.	Lurcher Lightship	Halifax Harbour	Sambro Lightship	Entry I., Que.	Port Borden, P.E.I.
January	1.1 -	3.8 -	1.0 -	0.9 -		-1.1 +
February	-0.1 -	3.2 -	1.0 +	0.0 -		-1.0 +
March	0.4 -	2.8 -	1.2	-0.2 -		-0.4 +
April	3.2 -	3.8 -	4.1 +	1.2 -		1.3 -
May	6.3 -	5.3 -	6.2 -	5.2 -	6.3 +	8.3 +
June	9.1 -	7.5 -	11.3 +	9.7 +	9.4 -	13.6 +
July	12.0	8.8 -	13.5 -	12.1 -	14.2 -	18.6 +
August	13.0 -	9.9 -	14.7 -	15.6 -	17.3 +	19.3 +
September	12.3 -		15.5 +		14.7 -	17.2 +
October	10.4 -	9.8 -	12.8 +		9.9 +	12.2 +
November	7.6 -	8.8 -	8.9 +	8.7 +	5.8 +	6.8 +
December	4.5 +	6.7 -	5.2 +	5.7 +		2.3 +

+ above normal

- below normal

Average Monthly Temperature Variations from 1958-1959.

January to June	-1.6	-1.1	-0.9	-1.7	-0.7	0.0
July to December	0.0	-0.6	+0.7	+0.1	+0.2	+1.2
January to December	-0.8	-0.8	-0.1	-0.1	-0.1	+0.6

Temperature and Salinity Conditions
in Northumberland Strait

Between May and October, weekly observations of temperature and salinity were taken at a station off Richibucto in Northumberland Strait. The observations were made at three different levels, surface, 10, and 20 metres in conjunction with a program of lobster larvae investigations in the area.

In 1959, the temperatures at all levels were generally higher than normal, except for the month of July. During a six week period in August and September, the average temperature of the water column was 15.8°C as compared with a normal of 13.8°C . The lack of normal stratification was also a feature of the 1959 temperature conditions. The surface temperature conditions off Richibucto are similar to those at Port Borden and at Entry Island. The surface salinities in 1959 were higher than normal, but corresponded to the summer conditions of 1957. In 1959, from May to September, the average salinity of the water column was $29.2^{\circ}/\text{oo}$ as compared with a normal of $28.2^{\circ}/\text{oo}$. Normal stratification of salinity was absent during the summer of 1959 in contrast to normal stratification in 1957.

The lack of normal stratification, as observed in 1959, indicates more vertical mixing than usual. Such conditions may have some effects on the vertical distribution of plankton as compared with more stratified conditions in other years.

L. M. Lauzier

Seasonal Surveys of Oceanographic Conditions in Newfoundland Waters

A program of seasonal surveys of oceanographic conditions in southern and eastern Newfoundland waters has been completed. These surveys were designed to provide a quasi-synoptic coverage of the Grand Banks region including the adjacent portions of the Scotian Shelf and Laurentian Channel. A total of five surveys were carried out. Four surveys were made that covered each of the mid-season conditions from autumn 1958 to summer 1959. One survey provided data for an interesting comparison of winter conditions during a "warm" winter (1957-58) and a "cold" winter (1958-59). The distribution of surface temperatures for four seasons are illustrated in the diagrams.

Autumn 1958:

During the latter half of October, temperatures showed a considerable influence from the Labrador Current and the Slope Waters. Surface temperatures were less than 3.0°C in the vicinity of Cape Bonavista and higher than 16.0°C in the Slope Water band southwest of the Grand Banks. Autumnal cooling, with its accompanying increased vertical mixing, caused surface temperatures to reflect the presence or absence of cold sub-surface waters of Arctic origin. Thus, on the edges of the Grand Banks, temperatures were less than 6.0°C , while over the Banks surface temperatures were between 10.0°C and 12.0°C .

Winter 1959:

The winter of 1959 was accompanied by many storms and

gales. Ice conditions were heavy and extensive, covering large portions of the survey area. Sub-zero temperatures were found over the Banks and Shelf areas, and extensive patches of water with temperatures less than -1.0°C were located on the Grand Banks. The surface waters in the offshore areas were several degrees cooler than generally found at this time of year. The entire region appeared to reflect an increased flow of cold Labrador Current water and an intense winter chilling, accompanied by an expansion of the cold low salinity coastal waters into the deep offshore regions.

Spring 1959:

The cold waters of winter (March) had been warmed about 3 to 5 Centigrade degrees over most of the region. In the offshore areas, increases were more spectacular with the closing-in of the warm currents. The chilling effects of the Labrador Current were still in evidence along the Newfoundland coast and along the southeast face of the Grand Banks.

Summer 1959:

Surface temperatures showed a considerable recovery from winter and ranged from 10.5°C off the south coast of Newfoundland to 25.5°C offshore. The influence of the Labrador Current on the surface temperatures was still noticeable, but to a lesser degree than in earlier seasons. This was probably due to an increase of stratification in the surface layer.

The extent and thickness of sub-surface waters with sub-zero temperatures was greater than that found in recent years. The cold waters from the Gulf of St. Lawrence extended into the

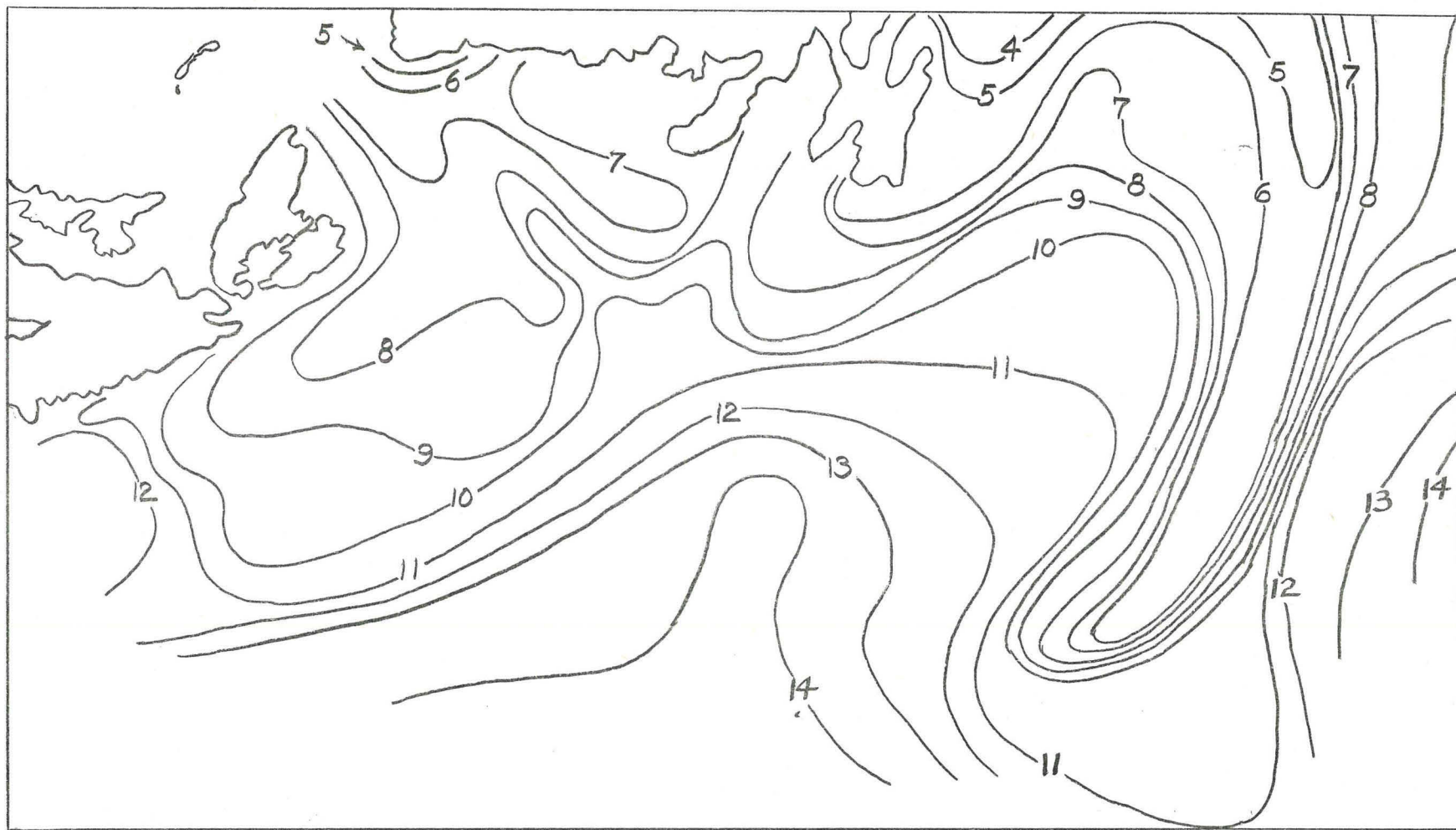
Laurentian Channel as far east as Burin Peninsula. The sub-zero Labrador Current waters extended along the south coast of Newfoundland almost to Cabot Strait. These waters were found along the northern face of the Grand Banks, but did not appear to be directly connected with a pool of sub-zero water located near the Tail of the Banks.

Also to wait... W.B. Bailey

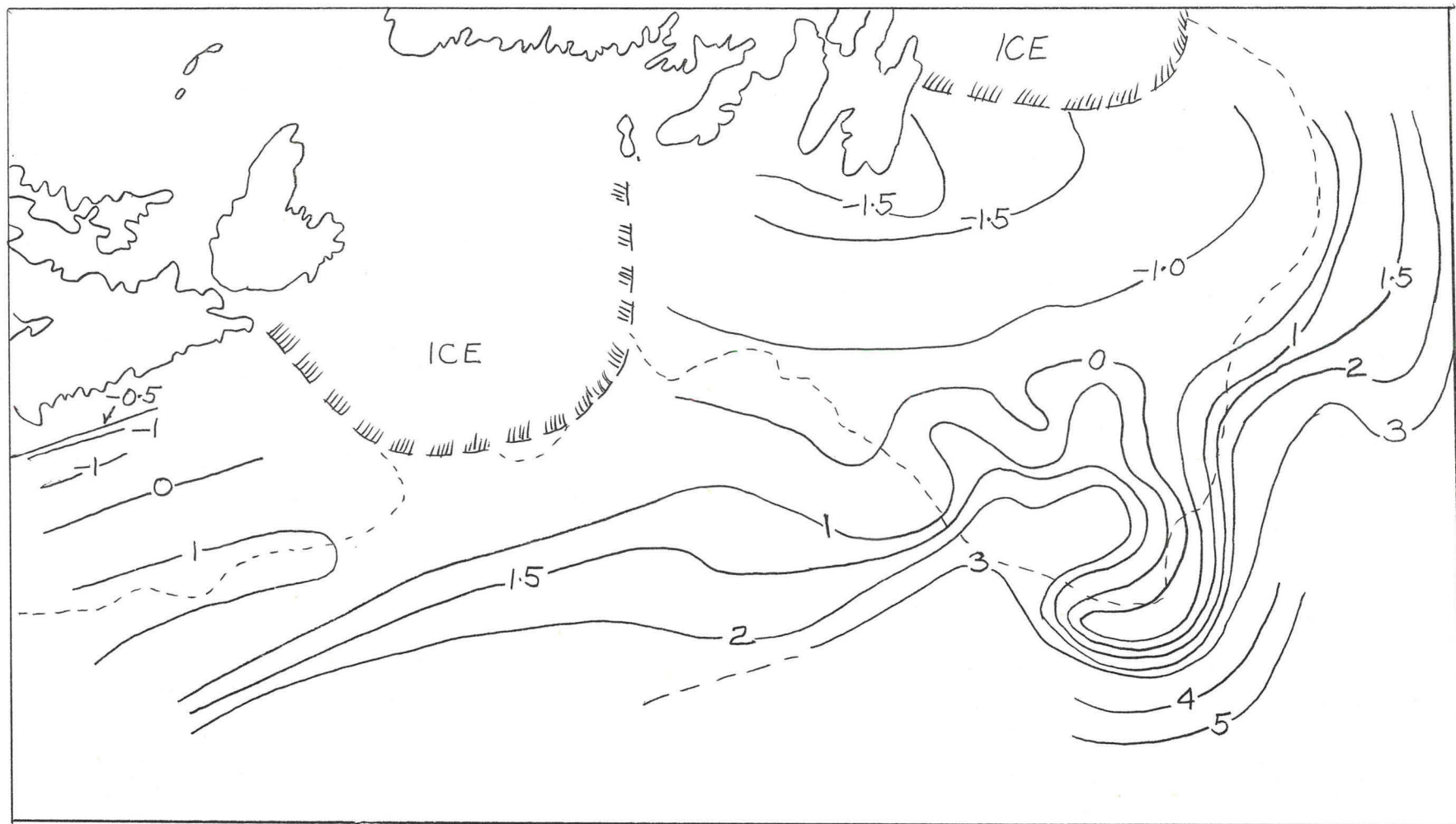
The cold waters of winter (March) had been warmed about 3 to 5 Centigrade degrees over most of the region. In the offshore areas, however, were more spectacular with the closing-in of the main waters of the Labrador Current were still in evidence along the Newfoundland coast and along the

and the temperatures showed a considerable recovery from... The influence of the Labrador current... This was probably due to a lesser degree than in earlier seasons. This was probably due to a lesser degree of stratification in the surface layer.

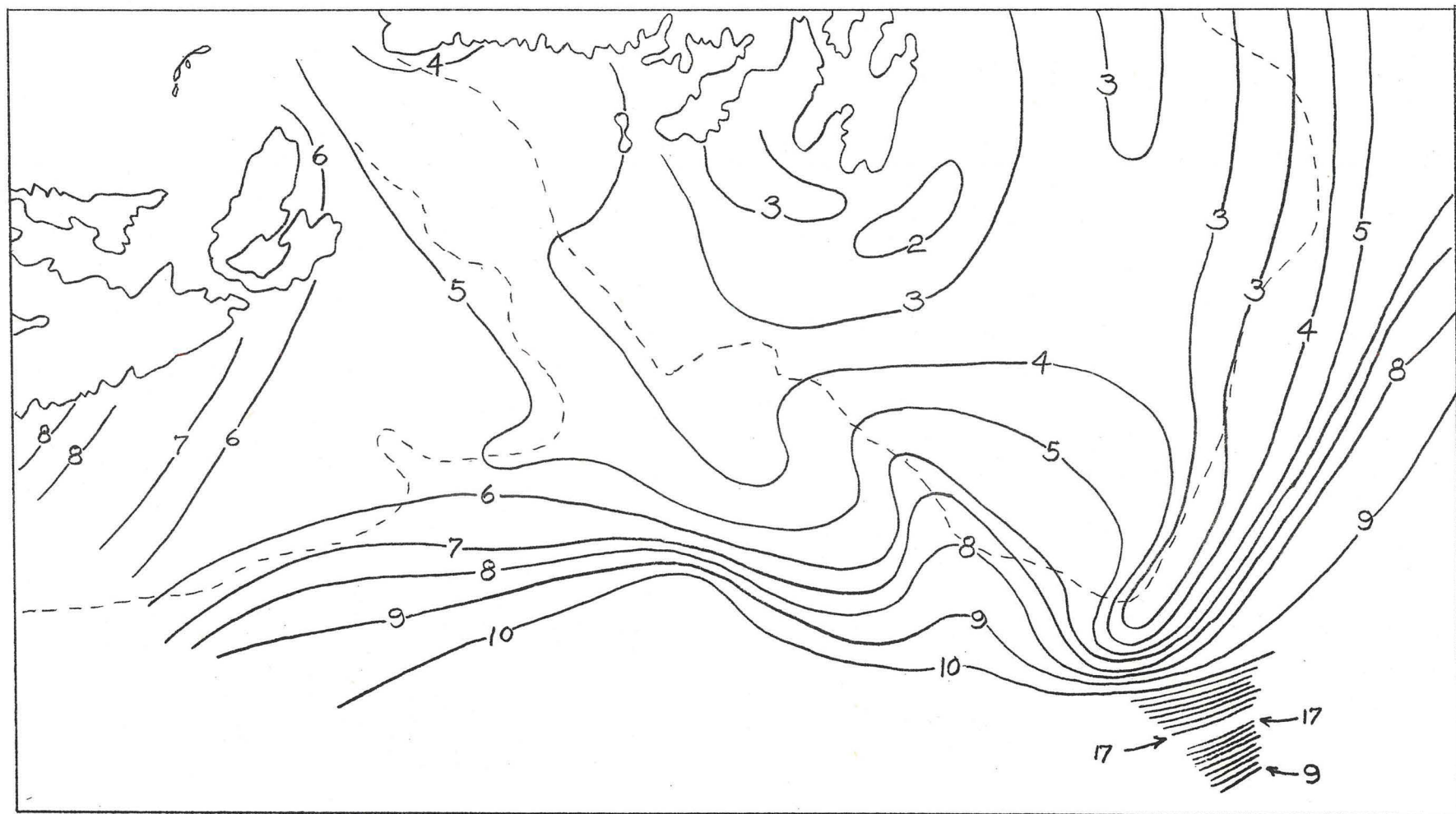
The extent and thickness of sub-surface waters with... The cold waters from the Tail of the Lawrence extended into the



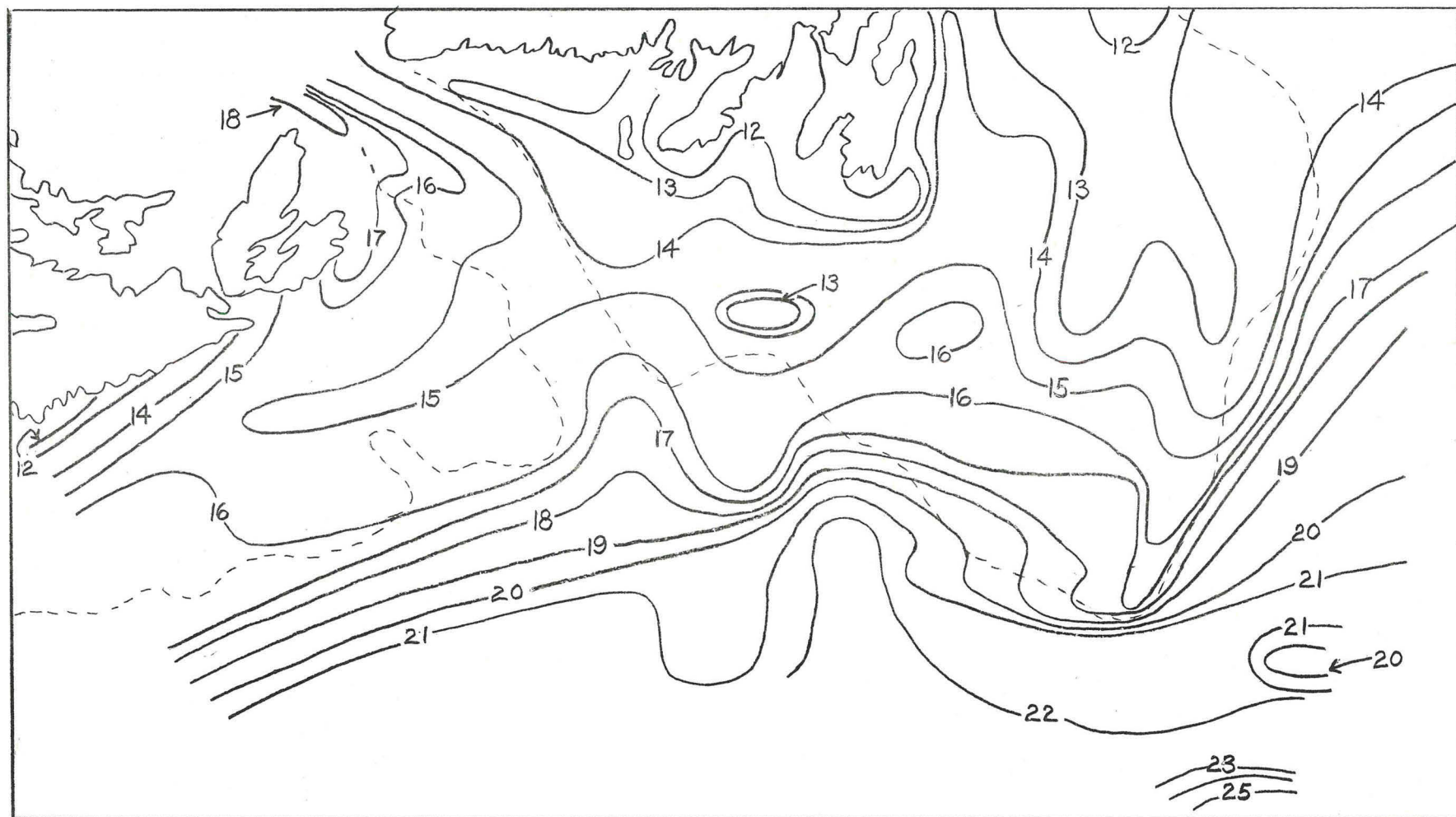
Surface temperature distribution in October, 1958.



Surface temperature distribution in March, 1959.



Surface temperature distribution in June, 1959.



Surface temperature distribution in August, 1959.

Variations in the thermal structure of
the Labrador Current

Since 1951, members of the staff of the Biological Station, St. John's, Nfld., have been taking oceanographic observations along four sections which traverse various sectors of the Grand Banks. The results of these observations have been presented in the Annual Report of the Biological Station, St. John's, Newfoundland.

In the study of oceanographic conditions of the waters in the Newfoundland region, these historical data made an important contribution to the understanding of secular trends in the Labrador Current.

The vertical distribution of temperatures for the years 1950-1958 show the same basic pattern for each year. There are, however, considerable differences in the extent of waters of varying temperatures. The cross-sectional areas of contrasting temperatures for each section, for each year of the period, have been measured and comparisons made.

A comparison of the areas occupied by waters with temperatures less than 0.0°C in the four sections indicates that between 1951 and 1954 the cross-sectional areas of this type of water increased and decreased together throughout the entire region. The relative changes in areas were not proportional. After 1954, there was little agreement, if any, amongst the sections. For instance, in 1957 there were relatively large amounts of cold water in the two central sections, but only a relatively small amount in the two end sections. These

discrepancies may be explained by considering the flow of cold water in the Labrador Current as taking place in distinct bodies, which may or may not be connected. Studies of the literature show that prominent formations of cold water reach the Grand Banks region in the early summer. Observations made at the same time each year show large variations from year to year in the sizes of the masses of cold water. These variations are influenced not only by the size of the formation, but also by the state of progression along the coast. The action of these two factors on the apparent size of a cold water mass results in a variation on the relative amounts of cold water.

Additional studies have indicated the influence of winds on water transport. In very general terms, it may be stated that large volume transports are associated with increased resultant wind mileages for May, June, and July. In addition, large volume transports are associated with higher mean temperatures in the Bonavista section. These transports are inversely related to the amount of water with temperatures less than 0.0°C . The amount of water with a temperature less than 0.0°C is directly related to the amount of bottom water ($> 3.0^{\circ}\text{C}$) and inversely related to the thickness of the surface layer ($> 3.0^{\circ}\text{C}$).

W. B. Bailey

Contrasting Wintertime Conditions in Newfoundland Waters

As part of a program of seasonal surveys in the Grand Banks and Laurentian Channel areas, oceanographic cruises were made in March 1958 and March 1959.

The two accompanying diagrams illustrate the distribution of minimum temperatures in the upper 200 metres of the water in the Newfoundland region.

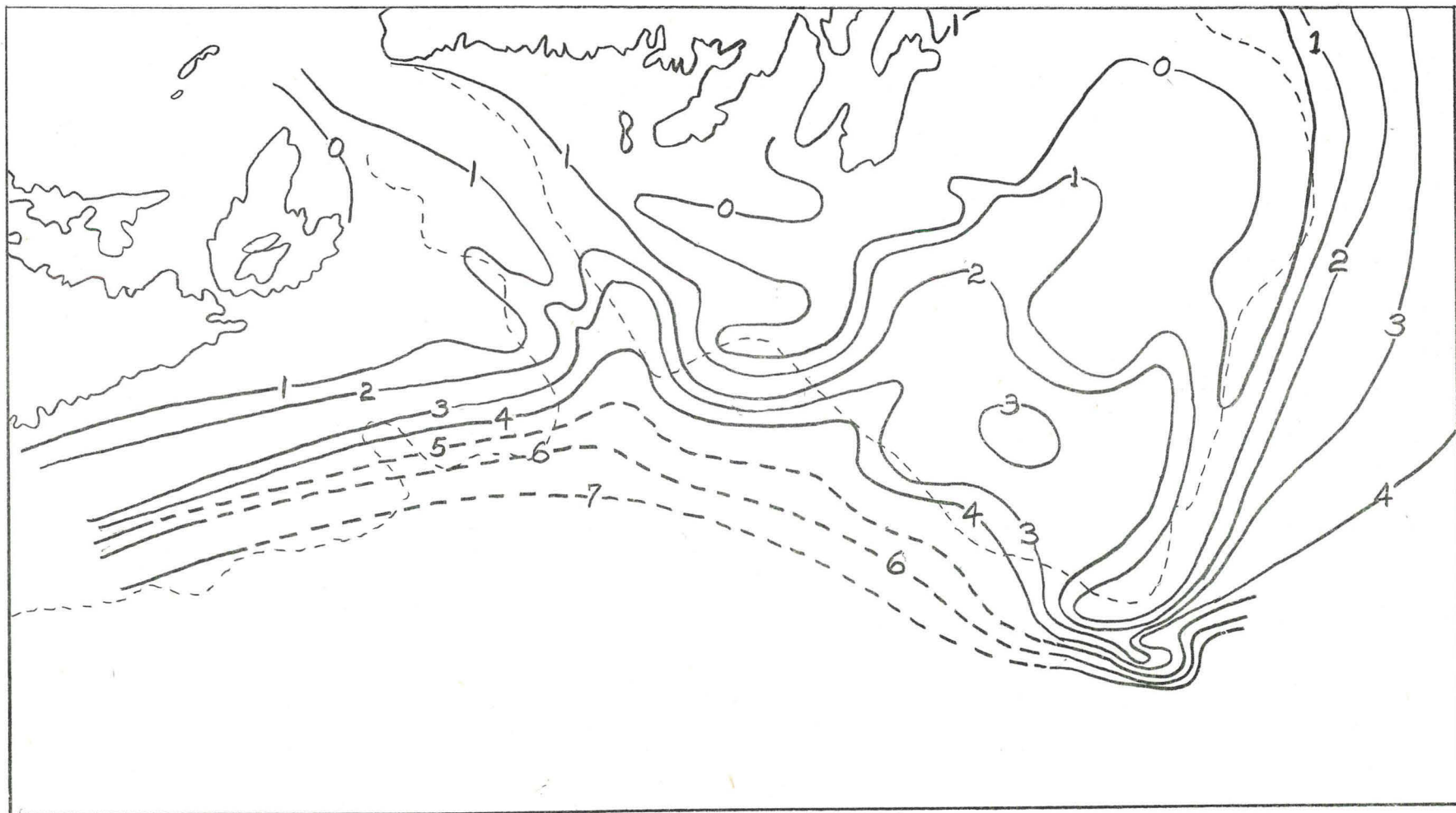
The relative position of the isotherms and the extent of ice cover for the two winters make interesting features for comparison.

A large tongue of warm water is usually found off the southwest face of the Grand Banks and towards the central portion of the Banks. In 1959, this tongue was considerably reduced in size and displaced towards the Tail of the Banks. The water in this eddy had a T-S characteristic quite distinct from those of the waters surrounding it. This would indicate that the waters in the eddy owe their origin to a displacement of coastal waters from the Scotian Shelf by an eastward movement of Slope Waters.

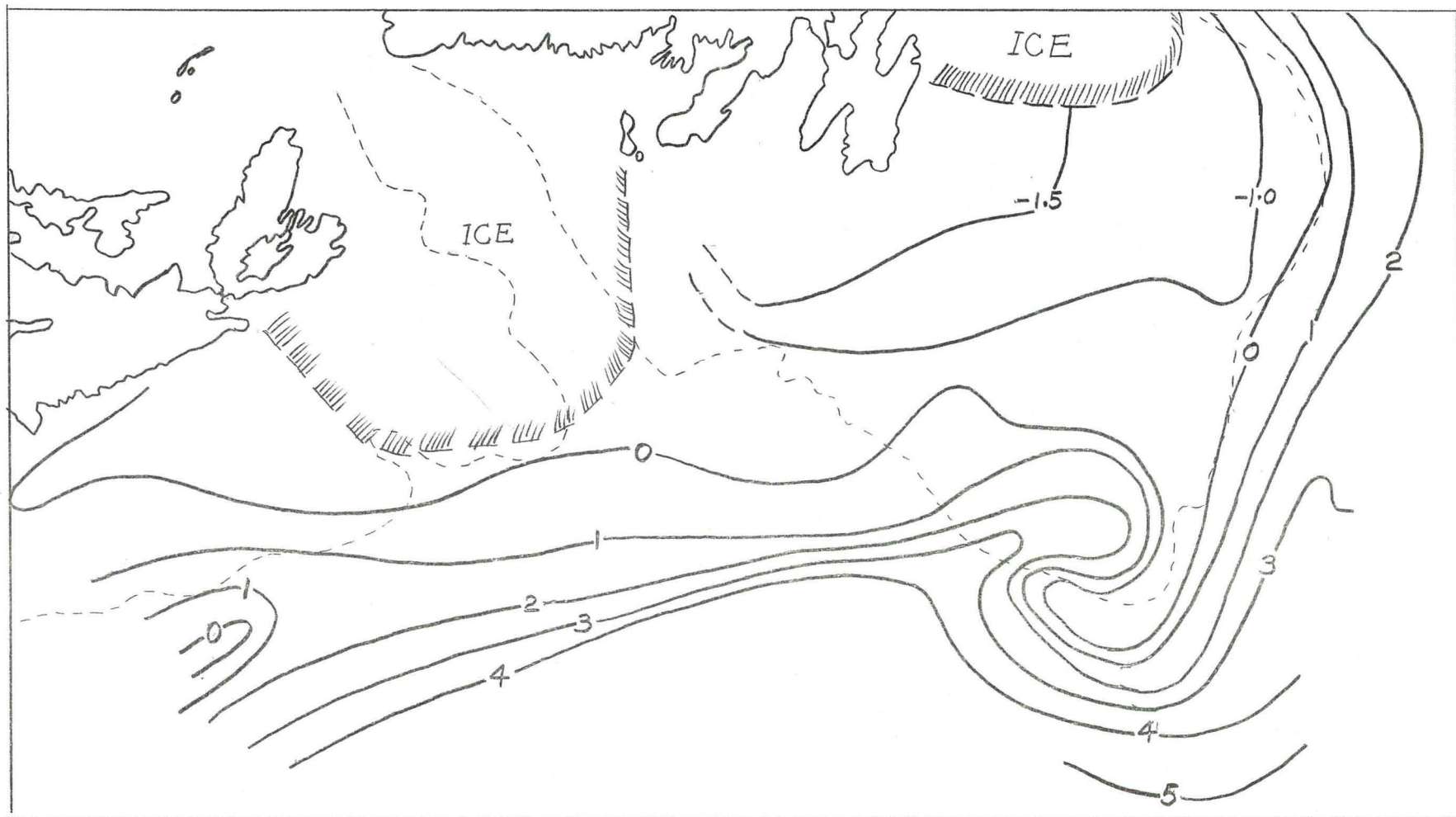
Temperature-salinity correlation curves indicate an increase from 1958 to 1959 in the amount of water of Arctic origin and from local cooling. On the Scotian Shelf, the lowered temperatures appear to result entirely from intense winter chilling in the inshore areas. In the northern part of the Grand Banks, the temperature distribution suggests an exceptionally large flow of Labrador Current water. However, irregularities in the T-S characteristics at all seasons of the year made it difficult to resolve the extent of local winter chilling and Labrador Current

water. Summer observations off Cape Bonavista showed the greatest cross-sectional distribution of sub-zero water of any year in the last ten. It is quite obvious that the extreme winter conditions of 1958-59 created very widespread chilling effects on the waters in the Grand Banks region.

W. B. Bailey.



Minimum temperature distribution in the upper 200 metres, March, 1958.



Minimum temperature distribution in the upper 200 metres, March, 1959.

Annual Variations of Temperature and Salinity in the
Grand Banks Region

Since the summer of 1946, oceanographic observations have been taken on a monthly basis at Station 27, located just off Cape Spear, Newfoundland (See Annual Report of Biological Station, St. John's, Newfoundland). *Chart?*

Analyses of these data have been carried out to determine the pertinent features of the annual cycle of both temperatures and salinities, and to assess the underlying causes of these features. Curves of normal monthly temperatures and salinities were determined, and those for four levels are shown in the accompanying diagrams.

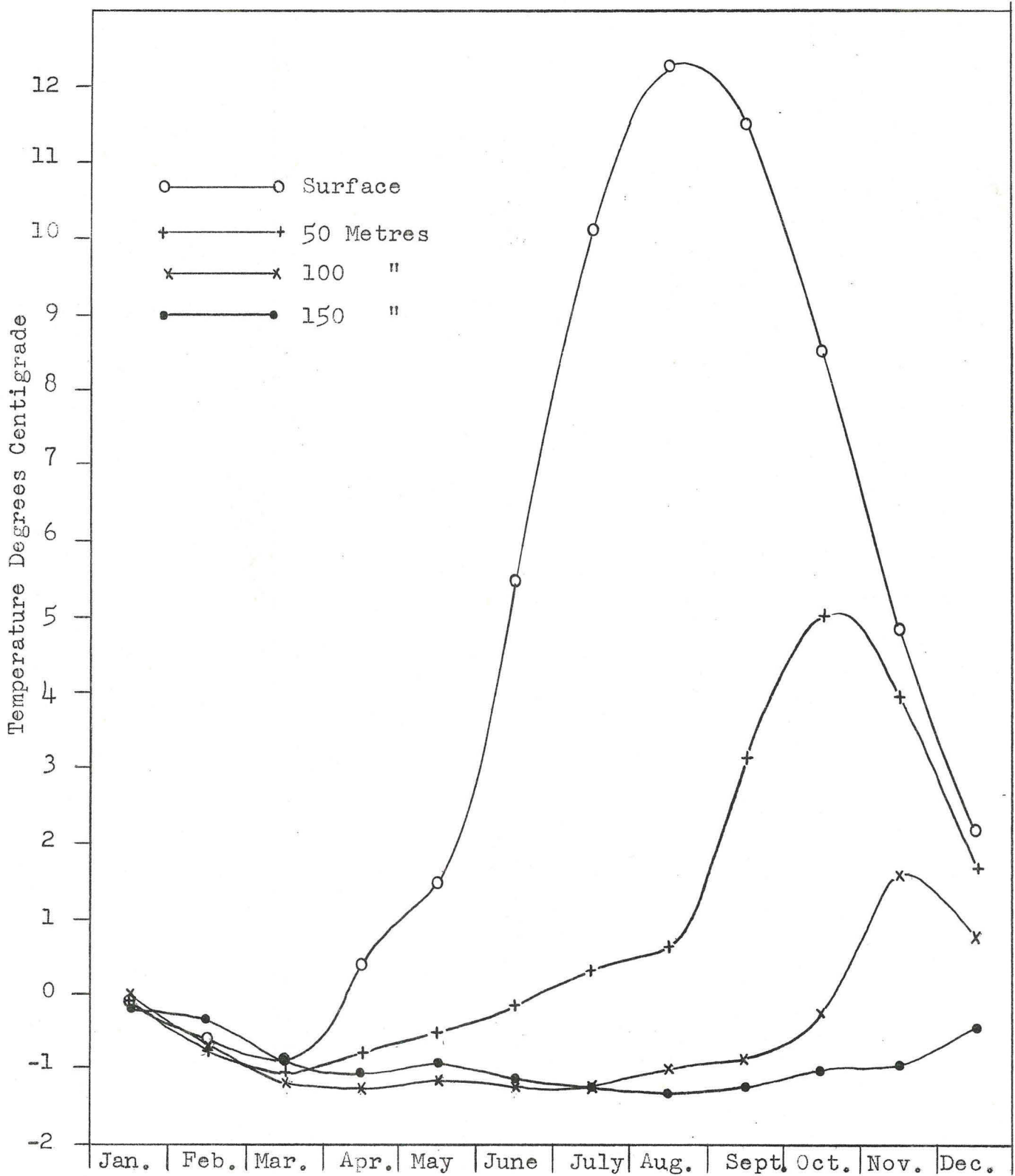
Studies resulting from the analyses indicate that the waters in the region, as exemplified by those at Station 27, have the following features:

- a. the waters are a mixture of surface waters and waters of Arctic origin.
- b. vertical mixing is slow; (about two months are required for maximum temperatures to traverse a 50-metre stratum).
- c. deviations from the normal temperatures and salinities provide some evidence that the "warm" and "cold" year phenomena take place at the same time throughout the entire Northwest Atlantic region.
- d. "warm" years appear to have lower salinities than "cold" years.

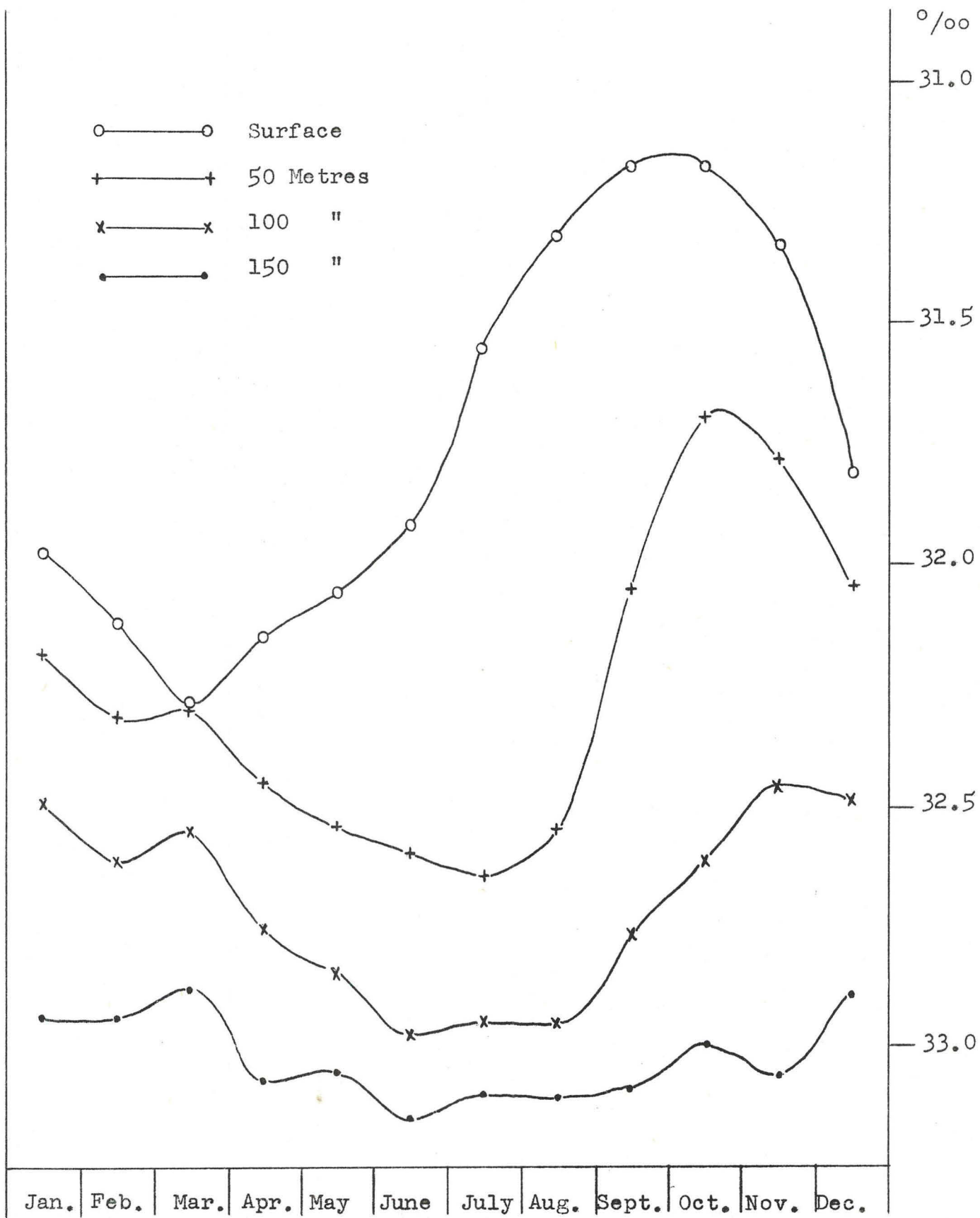
Several features of the normal mean monthly curves of temperatures and salinities at Station 27 are worthy of note.

The surface temperature curve is at a maximum in August, while at the depths of 50, 100, and 150 metres, peak thermal conditions are delayed two, three and five months respectively. A flooding of cold waters occurs in the early spring, cooling the 50 to 150 metre levels. Probably these waters originated along the north coast of Newfoundland where they have undergone winter chilling. The initial flooding of cold water appears to be followed by a second intrusion of cold high salinity water in early summer. The effects of this intrusion are confined principally to the deep levels. Using a mean velocity of 5 miles per day for the Labrador Current, the source of the water can be traced as far north as the Hebron Fiord region of the Labrador Coast. The occurrence of a minimum surface salinity in the early autumn, rather than in the spring or early summer, indicates that the source of the fresh water is quite distant. Studies of the available evidence has lead to the conclusion that Lake Melville is the originating point of the fresh water.

W. B. Bailey



Monthly Mean Temperatures of Station 27 (1946-58)



Monthly Mean Salinities at Station 27 (1946-1958)

Daily Drift Bottle Release Project

A daily release of two drift bottles from "Lurcher" Lightship has been carried out since 1956. The results of these releases have proven of great value in reflecting broad seasonal and secular changes in surface circulation in the Bay of Fundy and Gulf of Maine. In the autumn of 1958, the release program was expanded to give better coverage by having daily releases at "Sambro" Lightship, off Halifax, and by the S. S. "Princess Helene", at a point approximately 10 miles offshore from Saint John, N. B.

Lurcher Lightship: During the past three years, 1694 bottles have been released. To date, 9.8% have been returned. It is interesting to compare the pattern of recovery by seasons for the three years.

For those released in winter, 1957, all were recovered in St. Mary's Bay, whereas in 1958 the majority were recovered in the Cape Cod area. In 1959, most of the recoveries were taken between Digby and Yarmouth, but five were recovered from the Quoddy Region.

For spring releases, recoveries were principally from the Quoddy Region in 1957, and from the Coast of Maine in 1959. In 1958, recoveries were divided between the Quoddy Region and the Nova Scotia side of the Bay of Fundy.

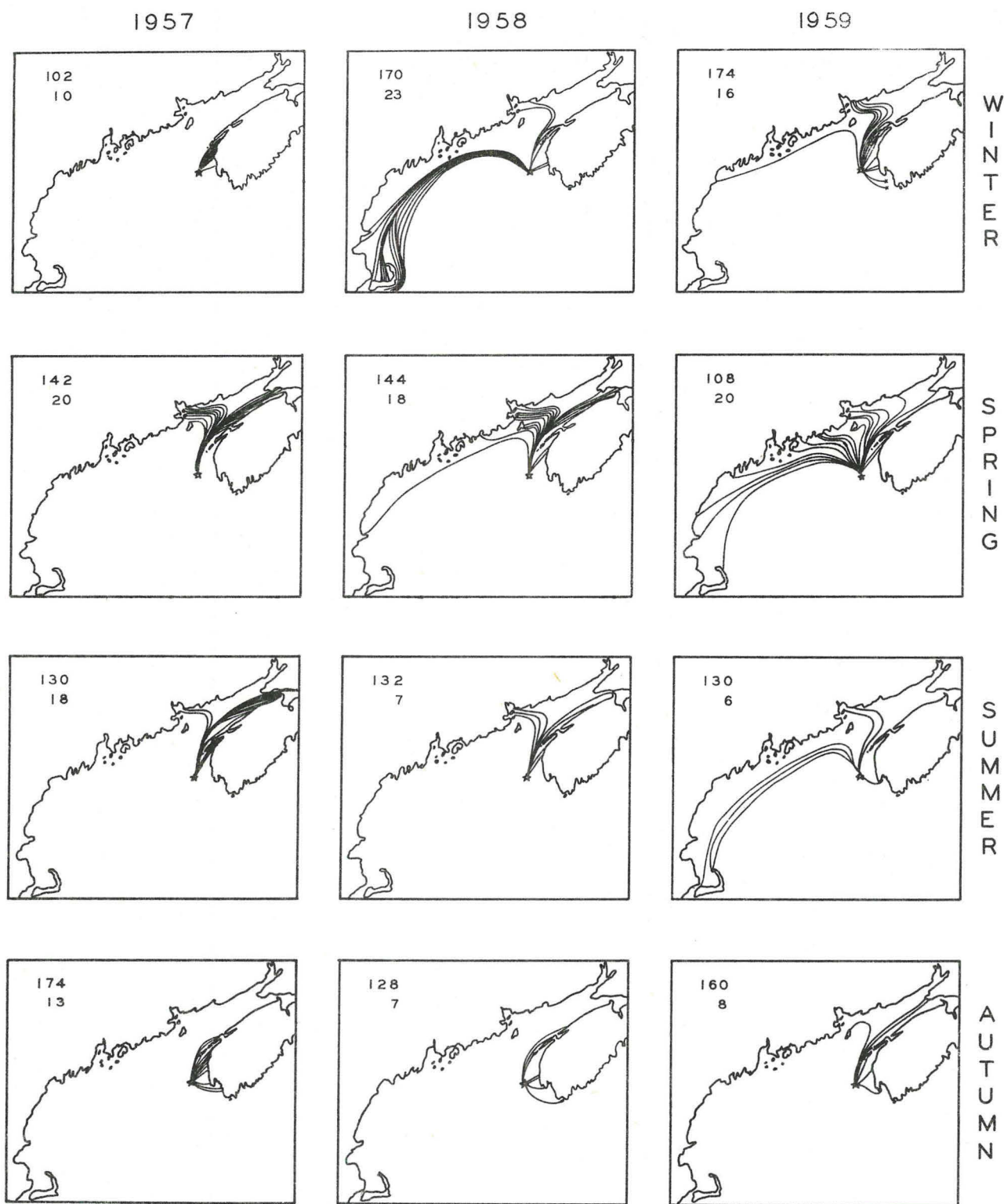
For summer releases, the general pattern was similar for the three years, except in 1959, when more returns were taken from the inner part of the Bay of Fundy, while three were returned from Cape Cod.

For autumn releases, the recovery patterns were similar in 1957 and 1958, but in 1959 there were recoveries from Minas Basin and Grand Manan, which indicate a greater inflow of water into the Bay of Fundy than for the previous two years.

Sambro Lightship: Of the bottles released at "Sambro" Lightship, approximately 7% have been returned. The recoveries were taken mostly between Halifax and Lunenburg, although a few were returned from all along the South Shore of Nova Scotia, and one from the Bay of Fundy, near Digby. Two were obtained from Sable Island. Very few were taken along the shore east of Halifax. In general, the bottles moved southwestward at all seasons with a marked onshore drift near the point of release.

S.S. "Princess Helene": Approximately 600 bottles were released in 1959, with a return to date of 8.9%. The areas of recovery have not varied markedly during the year, although the proportion returned from each area shows considerable variation. In winter, the recoveries were mostly from the Nova Scotia side of the Bay of Fundy. In spring, the bottles tended to move out of the Bay of Fundy and down the coast of Maine as far as Massachusetts. In summer, most of the recoveries were taken in the Quoddy Region, although a few were taken along the American Seaboard and three from the Nova Scotia side of the Bay of Fundy. In autumn, the returns were divided between the Quoddy Region and the Nova Scotia side of the Bay of Fundy.

In general, the results have tended to confirm the concept that the surface circulation pattern in the Bay of Fundy tends to be "closed" in winter and "open" in summer.



Returns of drift bottles released at Lurcher Lightship during 1957, 1958, and 1959. Numbers of bottles released and returned for each season are indicated in upper left of each diagram.

Drift Bottle Experiments in the Quoddy Region

In conjunction with the research program of the International Passamaquoddy Fisheries Board, approximately 10,000 drift bottles were released in the Quoddy Region in 1957 and 1958. The overall return of the bottles was 25%. The results have been analyzed and the surface drift inferred on a monthly and seasonal basis. It is concluded that, on the average, there is a counter-clockwise circulation in Passamaquoddy Bay, an outflow through Western Passage, a variable flow in Letite Passage, an outflow on the Campobello side of Head Harbour Passage, and an inflow along the Deer Island side of the Passage. In the Outer Quoddy Region, there is evidence of a clockwise circulation around the Wolves, a variable flow in Grand Manan Channel, and a southerly movement off the east coast of Grand Manan Island.

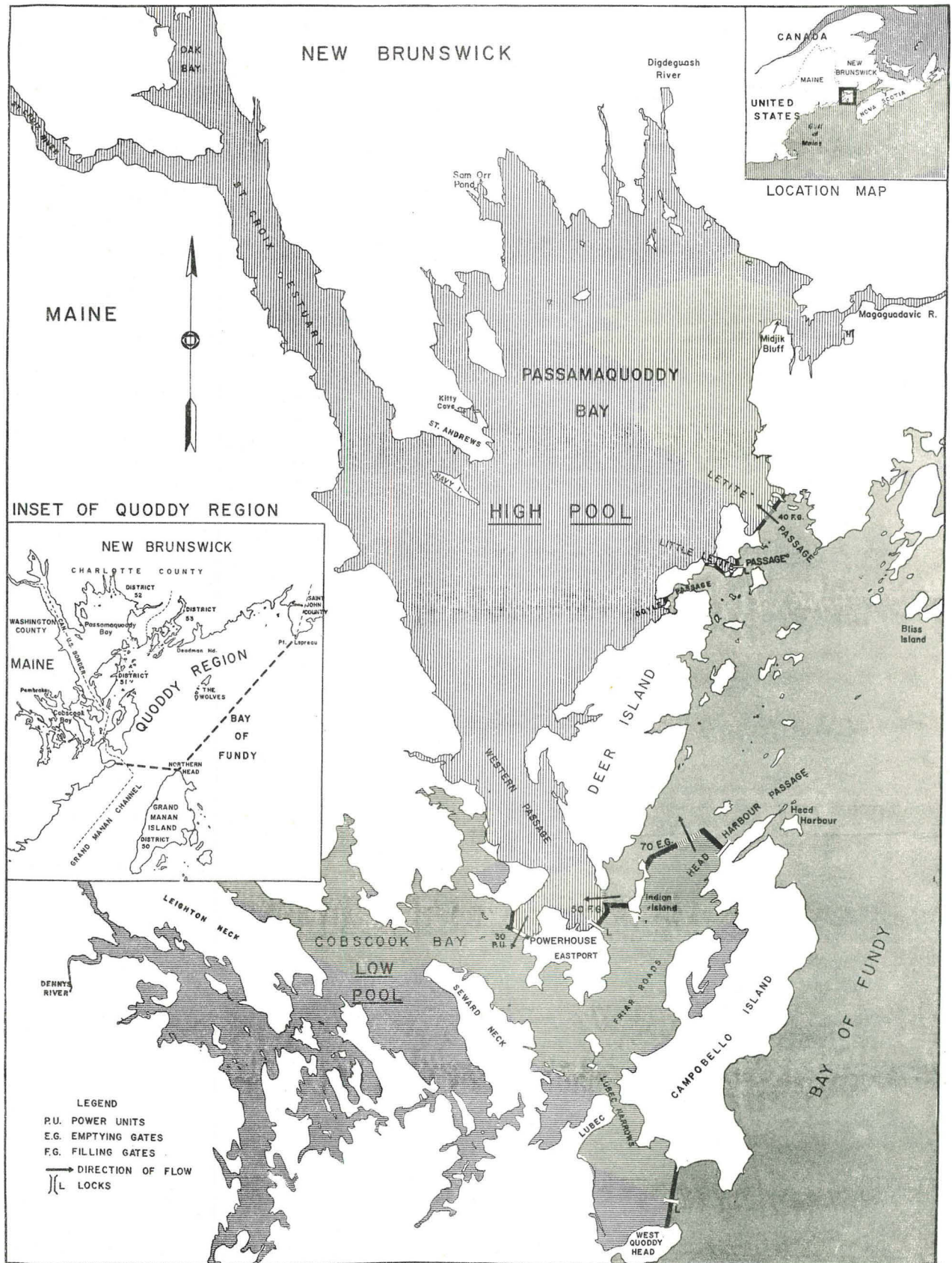
Wind speed and direction, which vary seasonally, appear very effective in altering the pattern of drift.

J. R. Chevrier.

Probable Effects of Proposed Passamaquoddy Power
Project on Oceanographic Conditions

The proposed Passamaquoddy power project involves the construction of a series of dams across the mouth of Passamaquoddy and Cobscook Bays. Passamaquoddy Bay, the proposed high pool, will be filled near high water by 90 filling gates, and Cobscook Bay, the proposed low pool, will be emptied near low water by 70 emptying gates. Water will flow continuously from the high pool to the low pool through a 30 turbine powerhouse. Tidal range will be reduced to approximately 4 feet and 8 feet in the high and low pools respectively. The effect of the proposed installation on oceanographic conditions in the region has been considered.

In the oceanographic study of the Quoddy Region the general features of the tides, circulation, and distribution of properties have been described, but only a qualitative evaluation of the relationship to the controlling factors has been possible. Without a moderately precise relationship between controlling factors and the circulation, etc., it is impossible to make precise predictions as to what will happen under a new set of conditions. However, it was constructive to consider pertinent aspects of other areas; Kennebecasis Bay, Oak Bay, Northumberland Strait, and British Columbia Inlets, in which certain oceanographic factors bear a degree of similarity to the proposed new conditions in the Quoddy Region. By making simplified assumptions on the mixing process expected under the proposed conditions, computations were made to predicate the distribution and accumulation of fresh water



Layout map of Passamaquoddy Power Project, showing high pool, low pool, filling gates, emptying gates, and powerhouse. The Quoddy Region is shown in inset.

in the St. Croix and Magaguadavic estuaries.

It was concluded that currents, within the impounded bays and in the area lying inside the Bliss Island - Head Harbour region will be altered markedly. In the outer Quoddy Region, tidal stream directions will be altered only slightly, while the changes in speed will probably not exceed 20% of the present value. No significant change in tidal streams or residual flow is expected outside the Quoddy Region. An increase in the tidal range, not exceeding one per cent, is anticipated for the entire Bay of Fundy. Inside the impounded bays there will be increased stratification accompanied by an increase in seasonal variations of temperature and salinity in the surface layer. The summer temperature maximum is expected to reach 20°C while the winter minimum will fall below 0°C. Ice is expected to form over part of the impounded waters. Salinities at the surface will be reduced. Only minor changes in temperature and salinity of the deep layer is anticipated. No significant changes are expected in temperature and salinity in the Outer Quoddy Region.

R. W. Trites

An Oceanographical and Biological Reconnaissance
of Kennebecasis Bay and the Saint John River Estuary.

A preliminary survey of the oceanographic features of Kennebecasis Bay and the Saint John estuarial system was carried out in 1957 - 58 as part of the International Passamaquoddy Fisheries Board Program, since physical and biological conditions in Kennebecasis Bay seemed similar to those expected in Passamaquoddy Bay if the dams were installed.

Kennebecasis Bay and Long Reach in the Saint John River are two layer estuarial systems with a brackish surface layer overlying a deep saline layer. Two sills separate and restrict exchange of deep water in Kennebecasis Bay from that of the Bay of Fundy. The formation of deep water in Kennebecasis Bay takes place initially in the gorge area between the two sills where saline water from the Bay of Fundy is mixed with the fresh water of the Saint John River. During periods of low river runoff and spring tides, a portion of the mixed water penetrates inward over the sill at the entrance to Kennebecasis Bay.

The results of this study have proved helpful in estimating the probable extreme conditions in Passamaquoddy Bay after impoundment. The locales differ, however, in two important aspects. One, is that the quantities and relative locations of fresh water discharge into the two areas differ. The other is that two sills separate the saline Bay of Fundy waters from the deep water in Kennebecasis Bay as compared to a single sill for the proposed conditions of Passamaquoddy Bay. From these studies

it was concluded that the distribution of properties in Kennebecasis Bay represents more extreme conditions than would be expected in Passamaquoddy Bay if power dams were installed.

R. W. Trites

The electrical potential differences recorded by the
transmitter system are generally followed for specific tidal stages,
both directly and from maps prepared. More than 60% of the
local tidal flow into Passamaquoddy Bay was found to pass through
Western Passage. The average duration of the flooding tide was
found to be approximately six hours, and for the ebbing tide, nearly
six and one-half hours. The results showed that slack water in
Western Passage occurred at a later time than in Little Passage.
This time lag varied from 15 to 30 minutes with some degree of
irregularity, although difficulty and uncertainty arose in
establishing the time records were corresponding to slack water.
It was concluded that the residual flow, while seldom very
pronounced, was, on the average, outward through Western Passage.

R. W. Trites and D. G. MacGregor

Flow of Water in the Passages of Passamaquoddy Bay

Measured by the Electromagnetic Method.

The electromagnetic induction method of measuring water transports was applied to the St. Croix estuary and some of the passages of the Quoddy Region in the period 1957 - 59.

The evaluation of water transports through the various passages connecting Passamaquoddy Bay and the Bay of Fundy is an important element in the oceanography of the Quoddy Region and is one phase of the studies that were undertaken as part of the program of the International Passamaquoddy Fisheries Board.

The electrical potential differences recorded by the installations systematically followed the changing tidal streams, both diurnally and from neaps to springs. More than 60% of the intertidal flow into Passamaquoddy Bay was found to pass through Western Passage. The average duration of the flooding tide was found to be approximately six hours, and for the ebbing tide, nearly six and one-half hours. The records showed that slack water in Western Passage occurred at a later time than in Letite Passage. This phase lag varied from 15 - 60 minutes with some degree of periodicity, although difficulty and uncertainty arose in establishing the true recorder zero corresponding to slack water. It was concluded that the residual flow, while seldom very pronounced, was, on the average, outward through Western Passage.

R. W. Trites and D. G. MacGregor.

Geological Oceanography in the Bay of Fundy

and Gulf of St. Lawrence

During 1959 - 60, one hundred and ninety-seven bottom samples were taken by the Atlantic Oceanographic Group along the Atlantic Coast. Ninety-nine of these samples were taken in the Bay of Fundy and Gulf of Maine, and ninety-eight in the Gulf of St. Lawrence and along the northern Cape Breton Coast.

In the Bay of Fundy, a variety of sedimentary types were found. On the western side of the bay the sediments were fine (<2 mm) and poorly-sorted, while in the central and eastern parts the sediments were coarse (>2 mm) and well-sorted. Sedimentation in the Bay of Fundy is believed to be closely related to water movements; this relationship is presently under study.

Consistently fine sediments, mostly silt and clay, were found in the deep waters of the Gulf of Maine. In contrast, coarse sediments were found on Georges Bank with pebbles predominating in the northern section.

In both the Bay of Fundy and the Gulf of Maine, the coarse sediment-rock fragments were sub-angular and rounded and were composed of many rock types. The features of the coarse sediments indicate the possibility that they were transported by Pleistocene ice. The fine sediments (2.0 - 0.5 mm) were composed mainly of quartz and feldspars.

In the Gulf of St. Lawrence, sampling was done mainly in the Miscou - Shippigan area and the Laurentian Channel. The sediments in the Miscou - Shippigan area were found to be mostly silty sand in the deep waters. The fine sediments were composed predominantly of quartz and feldspars. In the shoal coastal waters, coarse

sediments were found. The coarse sediments as in the Bay of Fundy and Gulf of Maine were composed of many rock types.

Some of the sampling was conducted on CGS "A. T. Cameron". Drags were made from the ship along the border of the Laurentian Channel, returning large boulders on several occasions. The boulders, up to seventy-five centimeters in diameter, were generally well-rounded and many rock types were represented. The presence of these boulders in the Gulf is attributed to transport by Pleistocene ice.

Samples in the Laurentian Trough, from Seven Islands, Quebec, to Cape Breton, Nova Scotia, were remarkably consistent in colour and particle size. An olive grey silt-clay was found in all deep waters of the Laurentian Channel.

F. D. Forgeron

A Study of the Marine Sediments of
the Canadian Eastern Arctic Archipelago

During the 1957 cruise of H.M.C.S. "Labrador", an active submarine geological program was undertaken as part of the oceanographic investigations in the Canadian Archipelago. The purpose of the geological investigation was to provide a preliminary survey of the marine sediments of the Canadian Eastern Arctic Archipelago.

The scope of the study was limited primarily to a size analysis for the purpose of obtaining a more complete understanding of the effects of the modes of transportation in the arctic regions.

The area covered included the waters off the coast of Labrador, and in Hudson Strait, Baffin Bay, Lancaster Sound, Franklin Strait, Prince Regent Inlet, the Gulf of Boothia, Wellington Channel, Peel Sound, and adjacent smaller bodies of water.

Examinations were made on 126 grab samples and 30 cores taken from the area.

The sediments were mostly poorly-sorted olive gray material, with fragments in all grade sizes from cobbles to fine clay. The rock fragments were generally subrounded to subangular. The larger fragments were faceted and often had the tabular and flat-iron shapes associated with glacial transport. Pitting was common on the fragments found in the marine sediments and on the rocks of the surrounding land.

Pebbles and cobbles occurred most abundantly in zones

extending for several miles from shore. The sediments in the deeper waters far from shore were predominantly silts.

The cores showed that sedimentary conditions have generally remained constant over most of the area for the length of time represented by the samples. Several cores taken adjacent to the northern part of Baffin Island contained layers which indicated changing conditions of deposition.

The relief of the sea floor is apparently determined by the attitude of the underlying rock beds.

The rate of marine sedimentation is apparently quite rapid due to rapid erosion on the surrounding land, with little vegetation to retard runoff. The extensive ice rafting is able to transport material from the beaches to areas offshore.

The composition of the sediments is comparable to that of tills described elsewhere in the world. It is possible that some till deposits formed in the past were deposited under conditions similar to those of the Arctic Archipelago.

Richard B. Perry

N. J. Campbell

Geological Oceanography in the Gulf of St. Lawrence

Reconnaissance submarine geological surveys of selected portions of the Scotian Shelf, Grand Banks, and in the Gulf of St. Lawrence (including the Bay of Chaleur) were carried out on two cruises during May and July 1959. Bottom sediment samples and short cores were obtained, together with the usual oceanographic data. Preliminary investigation of the bottom samples shows a large percentage are poorly sorted, consisting mainly of quartz grains with minor amounts of mica, ferromagnesian minerals, and lutite. Samples and cores from the Laurentian Channel are generally better sorted, fine grained muds and clays.

The microfaunas consist mainly of arenaceous and calcareous benthic Foraminifera variably distributed. Fauna lists are in preparation. Detailed geochemical, mineralogical and microfaunal studies of these and other bottom sediments are in progress.

Vertical plankton hauls were made and the microplankton studied for planktonic Foraminifera. The number of individuals and species present was extremely small; species of Globorotalia and Globigerina were noted.

In nearshore areas, echo sounding profiles and bottom contours of the Scotian Shelf, Gulf of St. Lawrence and the Bay of Chaleur suggest that the bottom topography of these regions is essentially a Pleistocene glacial landscape, subsequently drowned, and only slightly modified by post-Pleistocene erosion and sedimentation.

The possibility of seasonal (autumnal) overturning in the

Bay of Chaleur is suggested by (1) shallow depth, (2) a submarine ridge at the mouth (possibly a drowned terminal moraine) and (3) layered sedimentation observed in some short cores. Detailed study of this phenomenon is planned for the near future.

K. E. Hooper

Some Oceanographic Features of Northern Hudson Bay,
Foxe Channel, and Hudson Strait

Two oceanographic field programs were undertaken in Foxe Basin, Foxe Channel, Hudson Strait, and Hudson Bay in 1955 and 1956. Studies have continued from these programs in an effort to complete the work undertaken by HMCS "Labrador".

The water region bounded by northern Hudson Bay, Evans Strait, Foxe Channel, and Hudson Strait is an area of complicated currents and mixed water conditions. The region is also further complicated by marked differences in bottom topography associated with Paleozoic and Precambrian rock formations. A submarine ridge which extends across from Southampton Island to Nottingham Island directs the deep component of an outflowing current from the western side of Foxe Channel into Hudson Strait. Surface and intermediate waters also follow the same path, but some of these waters pass over the ridge and enter Hudson Bay and Evans Strait.

Surface and intermediate water characteristics in Hudson Bay are thus a mixture of waters originating from Hudson Bay and Foxe Channel. To these must also be added waters from Hudson Strait which enter the Hudson Bay - Foxe Channel region through the island chain that extends across the western end of Hudson Strait.

Different and distinct deep water masses appear in northern Hudson Bay, Foxe Channel, and Hudson Strait. Below 200 metres, typical water temperatures in Foxe Channel are -1.73 to -1.85°C , -1.50 to -1.69°C in Hudson Bay, and -1.45 to -1.51°C

in western Hudson Strait. Salinities vary from 33.30 to 33.87‰ in Foxe Channel compared with a variation of 33.10 to 33.26‰ in Hudson Bay and 33.20 to 33.35‰ in western Hudson Strait.

The oceanographic field programs were undertaken in

Foxe Basin, Foxe Channel, Hudson Strait, and Hudson Bay in 1955

and 1956. The N.J. Campbell

effort to complete the work undertaken by HMS "Labrador".

The water region bounded by northern Hudson Bay, Evans

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complicated by marked differences in bottom topography associated

with felsic and Precambrian rock formations. A submarine

ridge which extends across from Southampton Island to Nottingham

Island divides the deep component of an outflowing current from

the eastern side of Foxe Channel into Hudson Strait. Surface

and intermediate waters also follow the same path, but some of

these waters may enter the ridge and enter Hudson Bay and Evans

Strait.

Surface and intermediate water characteristics in

Hudson Bay are thus a mixture of waters originating from Hudson

Bay and Foxe Channel. To these may also be added waters from

Hudson Strait which enter the Hudson Bay - Foxe Channel region

through the island chain that extends across the western end of

Hudson Strait.

Diffuse and distant deep water masses appear in

northern Hudson Bay, Foxe Channel, and Hudson Strait. Below

500 meters, typical water temperatures in Foxe Channel are -1.73

to -1.87°C, -1.70 to -1.89°C in Hudson Bay, and -1.45 to -1.51°C

The Origin of Cold High Salinity Water in Foxe Basin
and Foxe Channel.

Abnormally low temperatures, -1.80 to -1.98°C and relatively high salinities, 33.75 to 34.07‰ were observed in Foxe Basin and Foxe Channel in the summer of 1955. These conditions represented a significant deviation from the normal character of the waters found in Hudson Bay and Hudson Strait.

The summer and fall distribution of the cold high salinity water extended northwards from Foxe Channel to almost the northern end of Foxe Basin. The origin of the water is a function of a number of oceanographic and meteorological factors. During a winter such as 1954-55, with below normal air temperatures, severe chilling of the waters is believed to have taken place in two unusual ways, at the surface in "winter open leads", and from the bottom.

Large "winter open water leads" exist in two regions of Foxe Basin, the one south of Fury and Hecla Strait and the other north of Foxe Peninsula. The explanation for these open areas has been attributed to winds, but it is believed that the extreme turbulence of the water plays some part in keeping the regions open. In either case, it is known that the turbulence constantly replenishes the water at the surface. This phenomenon, associated with low air temperatures, is effective in chilling the water, but in order to attain the values of temperature and salinity as observed, it appears obvious that frazil ice must form in the turbulent waters.

Cooling from the tide flats is also believed to be another effective process of reducing the temperature and raising the salinity. The tide flats in Foxe Basin comprise almost one tenth of the basin area and are in some regions over six miles wide. This part of the sea bottom is alternately exposed to the atmosphere and covered with water on each change of the tide. Ice can form on the bottom and the removal of fresh water by this means will, in time, increase the salinity of the water. These processes, repeated many times over, will gradually render the extremely cold saline water. Subsequent mixing and redistribution of the water will bring it into the deep areas of Foxe Basin and Foxe Channel.

N. J. Campbell

Groundfish Cruises

Two Groundfish cruises of the "A. T. Cameron", February-March, 1959, and January, 1960, were supported by the Atlantic Oceanographic Group. Co-ordinated fisheries and oceanographic programs were undertaken at sea and joint analyses of data will follow. Some of the oceanographic conditions are briefly described herein.

1. "A. T. Cameron" Cruise 5, Feb. 22 - Mar. 9, 1959.

The area covered included part of the lower Laurentian Channel, Banquereau, Sable Island Banks, and Emerald Bank. The cold water conditions that persisted over Banquereau resulted from intense winter cooling; bottom temperatures were found as low as -0.8°C . Along the edge of the Continental Shelf, the temperatures were of the order of 3°C . Bottom waters surrounding Sable Island were cold, with temperatures of about 1.0°C . To the north and northwest of Sable Island, warm bottom waters between 6 and 7°C were observed, but were contained beneath a deep, sharp positive thermocline. On Emerald Bank and the southwest Sable Island Banks, the bottom waters were relatively cold, between 3 and 5°C . In all areas explored, the bottom waters were abnormally cold. This condition was directly associated with the heavy ice concentrations.

2. "A. T. Cameron" Cruise 16, January 17 - 25, 1960.

The area covered included the Laurentian Channel, its western slope from the Magdalen Islands to Gaspe Peninsula and the entrance to the Bay of Chaleur. The temperatures were typical of early winter conditions. The thickness of the mixed layer, within which the

temperatures fell below -1.0°C , was such that in the northern part of the Magdalen Shallows it reached most of the bottom down to roughly 90 - 100 metres. On the basis of previous winter data, it is expected that, during the month of February, this layer will continue to increase in thickness in the northern sector and to spread to the southern sector, eventually covering most of the bottom.

The temperature conditions in the deep layer of the Laurentian Channel, from Cabot Strait to the Gaspé Passage, were normal with the 4° water at an approximate depth of 200 metres.

L. M. Lauzier

Drift Pole Experiments

Two series of drift pole experiments were conducted in the Gulf of St. Lawrence last autumn. The first series, in the Gaspé Passage, and in the Cabot Strait, was made in connection with occupation of oceanographic stations in these passages. The second series was made at the entrance to the Bay of Chaleur between Cape Gaspé and Orphan Bank.

The drift poles used for these experiments were designed and constructed at A.O.G. The drift poles are approximately 30 feet long and are fitted with radar reflectors at the top and three biplane-shaped drags in tandem at the bottom. When properly buoyed, about 12 feet of the pole protrudes above the water line. The poles are detectable up to a distance of 6 miles in good weather. Winds up to 15 miles per hour do not have any appreciable effect on the drift of the poles.

The first series of experiments was designed to obtain a reference point or surface velocity for the current and transport study in Cabot Strait and Gaspé Passage by dynamic methods. The results obtained are encouraging. It is planned to continue the use of the drift poles for this purpose, but also in connection with the Carruthers Pisa tubes at various depths above the bottom.

The second series of experiments, at the entrance to the Bay of Chaleur, was designed to study the Gaspé current to the south of Cape Gaspé. The drift poles were released on American Bank, 10 miles from the coast, and on the northwestern edge of

Orphan Bank at about 40 miles from the coast. Since no current of the strength and general direction of the Gaspe Current has been observed on either American Bank or Orphan Bank, it is believed that the Gaspe current is contained in the strip of water between American Bank and the mainland. At the time of these releases the Gaspe current, as observed west of Fame Point, was strong but narrow and shallow.

L. M. Lauzier

J. G. Clark

Technical Services

As a continuing service, the Atlantic Oceanographic Group has processed a large number of BT slides and analysed several thousands of water samples. The purpose of the service is to build a library of oceanographic observations, and to encourage other Canadian agencies to gather oceanographic information for their own uses.

The contributing agencies in 1959, excluding the Atlantic Oceanographic Group were the following:

- 1) Biological Station, St. Andrews, N. B.
- 2) Biological Station, St. John's, Newfoundland.
- 3) Arctic Unit, Montreal, Quebec.
- 4) Naval Research Establishment, Dartmouth, N. S.
- 5) Canadian Hydrographic Service, Ottawa, Ontario.
- 6) Polar Continental Shelf Project, Ottawa, Ontario.
- 7) Royal Canadian Navy.
- 8) miscellaneous.

The oceanographic data analysed for these agencies and AOG are summarized in the accompanying Table.

	Salinities	BT
Atlantic Oceanographic Group	4109	874
Biological Station, St. Andrews	548	636
Biological Station, St. John's	1530	847
Arctic Unit	122	62
Naval Research Establishment	-	436
Canadian Hydrographic Service	462	160

Table cont'd.

	Salinities	BT
Polar Continental Shelf	743	87
Royal Canadian Navy	-	355
Miscellaneous	72	-
	<u>7,586</u>	<u>3,457</u>

Additional data were obtained from Woods Hole, European publications, and IGY contributors. The data library was increased by 7,000 BT records and 800 serial oceanographic stations during the past year.

Preparations have been underway for the release of an oceanographic atlas of Atlantic coastal and offshore waters. The atlas will feature bottom conditions of temperature, salinity, sediments, etc. Other items of interest will be added to the atlas from time to time and released periodically.

G. B. Taylor.

BT	Salinities	
874	4109	Atlantic Oceanographic Group
636	248	Biological Station, St. Andrews
847	1530	Biological Station, St. John's
62	122	Arctic Unit
436	-	Naval Research Establishment
160	462	Canadian Hydrographic Service