THE BEDFORD INSTITUTE OF OCEANOGRAPHY:
A CHRONOLOGY OF THE FIRST FIFTY YEARS (1962-2012)

by

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Published by the
BIO-Oceans Association
Dartmouth, Nova Scotia

2018

ISBN 978-0-9936443-2-0

Correct citation for this publication:

Gordon, D.C. 2018. The Bedford Institute of Oceanography; a chronology of the first fifty years, 1962-2012. Dartmouth, NS : BIO-Oceans Association. (http://www.bio-oa.ca) v, 298 p.

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ABSTRACT

The Bedford Institute of Oceanography (BIO) is a federal oceanographic research facility located in Dartmouth, Nova Scotia, Canada. Since its establishment in 1962, BIO has grown to become Canada's largest centre for ocean research and has earned an international reputation for scientific excellence. BIO has conducted fundamental and applied research for the public good in all major marine science disciplines including engineering, hydrography, physical oceanography, chemical oceanography, geophysics, marine geology, marine ecology and fisheries. Many exciting discoveries of national and global importance have been made. Research programs have benefited from collaborative links with other government agencies, universities, industry and the international scientific community. Research results have been reported in the scientific literature and scientific advice on important marine issues has been provided to government decision makers, resource managers, marine industries and non-governmental organizations. This chronology documents the evolution of BIO over its first fifty years. Topics covered include organization and staff, facilities, ships, program, technology, conferences and workshops, honours and awards, prominent visitors and external events. It is hoped that this chronology will be of value to past, current and future BIO staff, as well as others in the broader oceanographic community who are interested in learning about the rich history of this remarkable Canadian institute.

RÉSUMÉ

L'Institut océanographique de Bedford (IOB) est une installation de recherche océanographique fédérale située à Dartmouth (Nouvelle-Écosse), au Canada. Depuis sa création en 1962, l'IOB est devenu le plus grand centre de recherche océanique au Canada et s'est bâti une réputation internationale d'excellence scientifique. L'IOB mène de la recherche fondamentale et appliquée pour le bien collectif de toutes les grandes disciplines des sciences de la mer, y compris l'ingénierie, l'hydrographie, l'océanographie physique et chimique, la géophysique, la géologie marine, l'écologie marine et les pêches. De nombreuses découvertes excitantes d'importance nationale et mondiale y ont été faites. Les programmes de recherche ont profité des liens de coopération de l'IOB avec les organismes gouvernementaux, les universités, l'industrie et la communauté scientifique internationale. Des résultats de travaux de recherche ont été publiés dans les ouvrages scientifiques, et des avis scientifiques traitant d'importants enjeux marins ont été fournis aux décideurs du gouvernement, aux gestionnaires de ressources, aux industries du secteur marin et aux organismes non gouvernementaux. Cette chronologie documente l'évolution des cinquante premières années de l'IOB. Les sujets traités comprennent l'institut et son personnel, les installations, les navires, les programmes, la technologie, les conférences, les ateliers, les distinctions, les visites marquantes et les événements externes. Cette chronologie est établie dans l'espoir qu'elle servira au personnel passé, présent et futur de l'IOB ainsi qu'aux membres de la communauté océanographique en générale qui pourraient être intéressés par la riche histoire de ce remarquable institut canadien.

DEDICATION

This chronology is dedicated to Dr. William L. Ford, Dr. Lloyd M. Dickie and Dr. Gordon A. Riley. These three outstanding scientists arrived in Halifax/Dartmouth in 1965. Drs. Ford and Dickie became directors at the Bedford Institute of Oceanography (BIO) while Dr. Riley became the director of the Institute of Oceanography at Dalhousie University. In subsequent years of working together, they played a major role in the development of BIO into a world-class oceanographic institution. They loved to go to sea and participated in oceanographic cruises whenever possible. These scientific leaders left a legacy that all BIO staff continue to enjoy today.

INTRODUCTION

The Bedford Institute of Oceanography (BIO) is a federal oceanographic research facility located in Dartmouth, Nova Scotia, Canada. Since its establishment in 1962, BIO has grown to become Canada's largest centre for ocean research and has earned an international reputation for scientific excellence.

Before 1962, Canadian marine expertise was limited and fragmented throughout the government and university research communities. It was understood that a carefully coordinated and expanded effort was necessary to develop a strong and comprehensive national oceanographic program. The concept was to develop a new centralized centre for oceanography in eastern Canada that would bring together existing federal agencies conducting marine science and surveying under one roof. Such a facility would allow efficient sharing of the necessary infrastructure for oceanographic research, enhance the exchange of ideas and information and lead to a better coordination of research between and within scientific disciplines, factors that would facilitate the development of the multidisciplinary research programs required to understand the ocean.

The establishment of BIO was a unique experiment in the management of federal government science initiated at a time when the federal government chose to allocate significant resources to meet the growing need for oceanographic research and develop Canadian expertise to address marine issues of importance to the public good of Canadians.

Over the years, BIO has conducted fundamental and applied research in all the major marine science disciplines including engineering, hydrography, physical oceanography, chemical oceanography, geophysics, marine geology, marine ecology and fisheries. Many exciting discoveries of national and global importance have been made. Research programs benefited from collaborative links with other government agencies, universities, industry and the national and international scientific communities. The results of the research have been thoroughly documented in the scientific literature and made available publically. Scientific advice has been provided on important marine issues to a wide variety of users including government decision makers, resource managers, marine industries and non-governmental organizations. These issues have included sovereignty, safety and security, environmental protection, health of the oceans, conservation and protection of marine life, safe and accessible waterways, natural resources (e.g., fisheries, minerals, oil and gas), effective adaptation to climate change and integrated management of large ocean areas. BIO has also responded efficiently to marine emergencies. While the structure and programs of BIO have evolved over time with changing priorities and the emergence of new issues, the underlying theme has always been conducting marine research for the public good of all Canadians.

In 2014, the Bedford Institute of Oceanography-ceans Association published *Voyage of Discovery: Fifty Years of Marine Research at Canada's Bedford Institute of Oceanography* (Nettleship et al. 2014) to commemorate the 50th anniversary of BIO. This comprehensive book contains 48 well-illustrated articles, written by 97 authors, that covered the general program areas of BIO including hydrography, geophysics, marine geology, physical oceanography, chemical oceanography, marine ecology, marine mammals, seabirds, fisheries, technology development and environmental management. The articles focussed on the science conducted, were technical in nature and did not cover all aspects of BIO programs.

This chronology, which is seen as complimentary to *Voyage of Discovery*, was compiled to provide a more comprehensive and balanced overview of how BIO evolved as a federal oceanographic research laboratory over its first fifty years. It builds upon earlier chronologies developed by Dale Buckley of the BIO Oceans Association and Carol Broome of the BIO Library. The information included came from numerous sources. The principal sources were the BIO Annual or Biennial Reviews that, with just a few gaps, were prepared between 1962 and 2009. These are available on line (www.bio.gc.ca/info/publications-en.php). The format of these reviews changed with time so there are some inconsistencies from year to year. Unfortunately, reviews were not prepared for the final three years covered which explains the fewer entries for this period. Other sources of information included *Voyage of Discovery*, published documents, internal reports, the Internet and personal contacts.

The chronology begins with a summary of some of the major events that took place in the development of marine science in Canada that helped set the stage for the establishment of BIO in 1962. This is followed by a year-by-year (1962-2012) listing of selected information under the headings of:

- Organization and Staff
- Facilities
- Ships
- Program
- Technology
- Conferences and Workshops
- Honours and Awards
- Prominent Visitors
- External Events

The chronology concludes with a Summary, Conclusion and Reference List.

It is hoped that this chronology will be of value and interest to past, current and future BIO staff, as well as others in the broader oceanographic community who are interested in learning about the rich history of this remarkable institute.

Many members of the BIO community contributed to the development of this chronology. Dale Buckley and Carol Broome prepared the earlier BIO chronologies that proved the stimulus for preparing this expanded edition. Numerous colleagues responded to my many questions and provided pertinent information. Allyn Clarke, Jim Elliott, Barry Hargrave, Mike Hughes, Paul Keizer, Tim Lambert, Mike Latrémouille, Mike Lewis, Bill Li, Dick MacDougall, Dave McKeown, Eric Mills, Charles Schafer, Tom Sephton, Mike Sinclair, Peter Wells and Phil Yeats kindly reviewed earlier drafts and offered many additions and constructive comments. Ellen Kenchington and Peter Cranford kindly reviewed the final draft. Kelly Bentham assisted in locating photographs and Cam Lirette assisted in preparing the figures. I thank them all for their contributions to this endeavour. I hope that the final product provides a balanced and valuable overview of the history of BIO over its first fifty years.

IMPORTANT EVENTS IN THE DEVELOPMENT OF CANADIAN MARINE SCIENCE UP TO 1962

This is a brief summary of some of the major events that took place in the development of marine science in Canada before the opening of the Bedford Institute of Oceanography (BIO) in 1962. More details can be found in other publications including a historical sketch of physical oceanography in Canada (Campbell 1976), a history of the Fisheries Research Board of Canada (Johnstone 1977), a review of Atlantic Canada fisheries biology (Hubbard 2006) and a review of Canadian marine science before 1962 (Mills 2014).

1842
Creation of the Geological Survey of Canada.

1862
Creation of the Nova Scotian Institute of Science.

1867
Passage of the Canadian Fisheries Act.

1873
The HMS *Challenger* sailed from Bermuda to Halifax and occupied a hydrographic section across the Gulf Stream.

1883
Creation of the Georgian Bay Survey.

1893
Creation of the Canadian Tidal and Current Survey.

Edward E. Prince (1858-1936) was appointed Dominion Commissioner of Fisheries.

1898
The Board of Management, composed of university and government representatives, was created to construct and manage a research station on the Atlantic coast.

1899
The Board of Management constructed a mobile floating laboratory that operated at various locations on the Atlantic coast until 1907.

1902
The International Council for the Exploration of the Sea (ICES) was created and based in Copenhagen, DK. Canada joined in 1967.

1904
The Georgian Bay Survey became the Hydrographic Survey of Canada and its responsibilities broadened to include the St. Lawrence River and the coasts.

The British Admiralty issued a circular to the more self-governing colonies requesting them to conduct hydrographic surveys along their own coasts.

1908
The Atlantic Biological Station in St. Andrews, NB, and the Pacific Biological Station in Nanaimo, BC, were established under the Board of Management.

1912
All automatic water gauges of Public Works on the Great Lakes and the St. Lawrence River became the responsibility of the Hydrographic Survey.

The Board of Management became the Biological Board of Canada and membership expanded to include the fishing industry.

1913
The CHS *Acadia*, built in Newcastle-on-Tyne, UK, arrived on the east coast and began her long career as a hydrographic survey vessel.

1915
The Canadian Fisheries Expedition was organized under the leadership of Dr. Johan Hjort, a distinguished Norwegian fisheries biologist. It was the first oceanographic study of the Gulf of St. Lawrence and Scotian Shelf. Fisheries science incorporated new physical and chemical techniques from Europe and studies of herring stocks and their environment inspired fish recruitment research for many decades.

1919
A proposal was brought forward for a transboundary tidal power development in Passamaquoddy Bay, NB, and Cobscook Bay, ME.

1920
The International Committee on Marine Fisheries Investigations was established. Initial members were Canada, the US and Newfoundland while France joined a few years later.

1924
The Tidal and Current Survey Division of the Department of Marine and Fisheries was transferred to the Hydrographic Survey.

1925
The Atlantic Fisheries Experimental Station in Halifax, NS, was established under the Biological Board of Canada. The Fisheries Technological Program began to provide scientific research and technical assistance to improve the handling, processing and quality of fisheries products in Atlantic Canada.

1928
The Hydrographic Survey of Canada was renamed the Canadian Hydrographic Service (CHS).

1930
After several intervening name changes, the International Committee on Marine Fisheries Investigations became the North American Council on Fisheries Investigations.

1931
The International Passamaquoddy Fisheries Commission was established by Canada and the US to study the potential effects of tidal power development.

The Newfoundland Fishery Research Laboratory was established in Bay Bulls, NL.

1937
After a devastating fire, the Newfoundland Fishery Research Laboratory moved to St. John's, NL.

The Biological Board of Canada became the Fisheries Research Board of Canada (FRBC). Under the Minister of Fisheries, the Board developed a network of fishery research stations across the country and conducted investigations of practical and economic problems connected with marine and freshwater fisheries, flora and fauna.

1944
The Naval Research Establishment was created.

The Atlantic Oceanographic Group (AOG) in St. Andrews, NB, headed by Dr. Harry Hachey, and the Pacific Oceanographic Group (POG) in Nanaimo, BC, headed by Dr. Jack Tully, were created under the Fisheries Research Board of Canada (FRBC). The early programs dealt primarily with physical oceanography but later expanded to include geology, chemistry and biology. Ship support was provided by the Royal Canadian Navy.

1946
The Joint Committee on Oceanography (JCO), composed of representatives from federal agencies and universities, was established to coordinate the development of oceanography in Canada.

The Nova Scotia Research Foundation was established.

The Defence Research Board, which included the Naval Research Establishment, was established.

1948
The UN International Civil Aviation Organization established an international network of thirteen weather stations that were regularly sampled by ship. Stations *Bravo* and *Charlie* were located off the coasts of Labrador and Newfoundland.

1949
The Canadian Hydrographic Service assumed responsibility for British charts of Newfoundland and Labrador.

The CHS *Kapuskasing*, a minesweeper commissioned in 1944 that carried out convoy escort duties during in World War II, was loaned by the Royal Canadian Navy to the Department of Mines and Technical Surveys (DMTS) and converted for conducting hydrographic surveys.

With the joining of Newfoundland to Canada, the Newfoundland Fishery Research Laboratory became the St. John's Biological Station under the Fisheries Research Board of Canada (FRBC).

An Institute of Oceanography was created at the University of British Columbia to offer graduate training in oceanography.

1950
The International Commission for North Atlantic Fisheries (ICNAF) was created for the investigation, protection and conservation of fisheries.

In collaboration with the Woods Hole Oceanographic Institute and the US Hydrographic Office, the Naval Research Establishment conducted Operation Cabot, a multi-ship survey of the Gulf Stream south of Halifax.

The Atlantic Oceanographic Group (AOG) established the Halifax Section, a series of stations southeast of Halifax across the Scotian Shelf that were sampled seasonally for many years to improve the understanding of water mass structure and movement.

1951
The CNAV *Sackville*, a Flower Class corvette built in 1941 that carried out convoy duties in World War II, was made available to the Atlantic Oceanographic Group (AOG) by the Royal Canadian Navy for oceanographic studies.

The CNAV *Sackville* participated in seismic reflection experiments in collaboration with continental shelf off Nova Scotia. This work laid the foundations for later surveys that demonstrated the potential for oil and gas reserves.

1954
The Canso Causeway was constructed.

1956
The Precise Water Levels Division and the Tidal and Current Survey Division were amalgamated and renamed Tides, Currents and Water Levels.

Dr. William E. van Steenburgh joined the Department of Mines and Technical Surveys as Director-General of Science Services. He subsequently became Deputy Minister in 1963.

The proposed trans-boundary tidal power development in Passamaquoddy Bay and Cobscook Bay was referred to the International Joint Commission for review that in turn established the International Passamoquoddy Fisheries Board to investigate the effects of dams upon regional fisheries.

1957

The CHS *Baffin* was delivered to the Department of Mines and Technical Surveys (DMTS) and began her long career as a hydrographic survey vessel.

Using the CNAV *Sackville*, the Atlantic Oceanographic Group (AOG) conducted hydrographic stations as part of the ICES-coordinated Polar Front Survey of the North Atlantic under the International Geophysical Year.

1958

At the 30th meeting of the Joint Committee on Oceanography (JCO), Dr. William E. van Steenburgh of the Department of Mines and Technical Surveys stated that the Department expected to establish a new oceanographic laboratory on the east coast to lead the advancement of Canadian oceanography.

The Canadian Hydrographic Service (CHS), based in Ottawa, opened a regional office in the Ralston Building in Halifax.

The Polar Continental Shelf Project was established.

1959

The Joint Committee on Oceanography (JCO) evolved into the Canadian Committee on Oceanography (CCO) that continued to operate under the same coordination mandate. The CCO decided that oceanography needed to be expanded in Canada. Although the Fisheries Research Board of Canada (FRBC) had both the Atlantic Oceanographic Group (AOG) and Pacific Oceanographic Group (POG) under its wing, it was not interested in further developing its oceanographic programs since its principal responsibility was fisheries. It was agreed that an expanded oceanographic program fitted better with the Department of Mines and Technical Surveys (DMTS) under the lead of Dr. William E. van Steenburgh.

Treasury Board approved funding for a new east coast oceanographic laboratory.

At the 32nd meeting of the Canadian Committee on Oceanography (CCO), the Department of Mines and Technical Surveys (DMTS) reported that plans for the new east coast oceanographic laboratory were progressing well. A site had been selected on the Dartmouth shore of Bedford Basin and construction of services and jetties was about to start.

The Institute of Oceanography (IODal) was created at Dalhousie University to offer graduate training in oceanography. The first director was Dr. F. Ronald Hayes.

The first offshore drilling leases were awarded to Mobil Oil.

1960
The Atlantic Oceanographic Group (AOG) of the Fisheries Research Board of Canada (FRBC) moved from St. Andrews to Halifax with Dr. Neil J. Campbell as Oceanographer-in-Charge. They occupied a group of single story wooden buildings (now gone) on Terminal Road across from the Nova Scotian Hotel (now the Westin). Staff continued to study the ocean environment with strong links to fisheries. The program was coordinated by the Canadian Committee on Oceanography (CCO) and there was considerable collaboration with the Dalhousie Institute of Oceanography. The geographic area of interest was the entire Atlantic Canada continental shelf including the Gulf of St. Lawrence and Gulf of Maine.

At the 34th meeting of the Canadian Committee on Oceanography (CCO), Dr. William E. van Steenburgh reported that a contract for a new oceanographic research vessel, the CSS *Hudson*, would be awarded shortly and that construction of the new Dartmouth laboratory, to be named the Bedford Institute of Oceanography (BIO), was proceeding satisfactorily.

The Oceanographic Research Division of the Department of Mines and Technical Surveys (DMTS) was established and Dr. William M. Cameron was appointed the first director.

The East Coast Working Party on Oceanographic Services for Defence was established to study, develop and recommend methods of meeting maritime warfare requirements in oceanography.

1961
The Marine Sciences Branch (MSB) was created under the Department of Mines and Technical Surveys (DMTS) with Dr. William M. Cameron as first director. It combined the operations of the Canadian Hydrographic Service (CHS) and marine research programs in physical and geological sciences.

The CHS *Maxwell*, designed for conducting hydrographic surveys, was delivered to the Department of Mines and Technical Surveys (DMTS).

1962
Over the summer, Canadian Hydrographic Service (CHS), Atlantic Oceanographic Group (AOG) and Marine Sciences Branch (MSB) staff started to move into the uncompleted buildings.

Dr. William N. English was appointed as the first Director of the Bedford Institute of Oceanography (BIO).

The Bedford Institute of Oceanography (BIO) was officially opened on 25 October 1962.

ORGANIZATION AND STAFF

This section documents the internal organization of the Bedford Institute of Oceanography (BIO) and identifies senior staff. It illustrates how the mandate of BIO evolved over the years and how the organization grew in complexity. Relevant aspects of regional and national government organization are included. The many non-government organizations and businesses that have been resident on the BIO campus over the years are also reported.

1962

The Bedford Institute of Oceanography (BIO) was officially opened on 25 October 1962. The Honourable Paul Martineau, Minister of Mines and Technical Surveys, and Dr. Jack L. Kask, Chairman of the Fisheries Research Board of Canada, gave speeches. Dr. William E. van Steenburgh, who led the creation of BIO, was in attendance. Over three hundred guests were invited, including The Honourable Robert L. Stanfield, Premier of Nova Scotia.

The Canadian Hydrographic Service (CHS) (part of the newly created Marine Sciences Branch in the Department of Mines and Technical Surveys) and the Atlantic Oceanographic Group (AOG) of the Fisheries Research Board of Canada (in the Department of Fisheries and Forestry), already well established organizations, moved from their offices in Halifax to become the first inhabitants of the new Institute. Most of the hydrographic work at the time was led by staff in Ottawa but responsibility was expected to shift to BIO as existing staff were transferred and new staff recruited. They were soon joined by other Marine Sciences Branch staff, either newly hired or transferred from Ottawa.

The lead agency for BIO was the Marine Sciences Branch of the Department of Mines and Technical Surveys. Dr. William N. English was the first director. As lead agency, the Marine Sciences Branch owned and operated the BIO buildings and ships.

Senior staff were:

- W.N. English, Director
- G.W. LaCroix, Regional Hydrographer
- C.R. Mann, Regional Research Oceanographer
- R.L.G. Gilbert, Engineer-in-Charge
- J.S. Horam, Regional Ships' Officer
- S.H. Scott, Administrative Officer
- N.J. Campbell, Scientist-in-Charge of the Atlantic Oceanographic Group

1963

BIO grew rapidly. Marine Sciences Branch staff from current surveys and hydrography transferred from Ottawa. The Marine Geology Unit of the Geological Survey of Canada, under Dr. Bernie R. Pelletier, also transferred from Ottawa and became part of the Marine Sciences Branch. New programs in theoretical oceanography and marine geophysics were established. Mr. L.P. Murdock became the Acting Regional Hydrographer when Mr. G.W. Lacroix was recalled to Ottawa.

The Oceanographic Services for Defence, manned by BIO staff, was established and located at the HMC Dockyard in Halifax.

The research program was organized as follows:

Department of Mines and Technical Surveys
Marine Sciences Branch Support Program

- Ships
- Engineering Services
- Oceanographic Services

Marine Sciences Branch Research and Technical Surveys Program

- Physical Oceanography
- Theoretical Studies
- Marine Geology and Geophysics
- Hydrographic Surveys

Department of Fisheries and Forestry
Fisheries Research Board of Canada
Atlantic Oceanographic Group Program

- Physical Oceanography
- Geology and Geochemistry
- Benthic Fauna Studies
- ICNAF and Chemical Oceanography

Senior staff were now:

- W.N. English, Director
- L.P. Murdock, Acting Regional Hydrographer
- C.R. Mann, Regional Research Oceanographer
- R.L.G. Gilbert, Engineer-in-Charge
- J.S. Horam, Regional Ships' Officer
- S.H. Scott, Administrative Officer
- N.J. Campbell, Scientist-in-Charge of the Atlantic Oceanographic Group

The Secretariat of the International Commission for Northwest Atlantic Fisheries (ICNAF) moved into BIO. The Executive Secretary was Mr. L. R. Day.

1964

Dr. F. Ronald Hayes replaced Dr. Jack Kask as the Chairman of the Fisheries Research Board of Canada in Ottawa. Dr. William N. English resigned as director and moved back to British Columbia to join the Pacific Naval Laboratory of the Defence Research Board in Esquimalt, BC. He had successfully guided the growth and development of the Institute during its formative first two years. Dr. L.A. Earl Doe was appointed Acting Director in his place and Dr. Reginald L.G. Gilbert assumed this responsibility while Dr. Doe was in Pakistan for two months. Mr. Russell

L. Melanson became Regional Hydrographer and Dr. Ronald W. Trites became the head of the Atlantic Oceanographic Group (AOG). Capt. A.M. Holler became the new Marine Superintendent.

A new Instrument Design Group was established. The Frozen Sea Research Group was seconded to work with colleagues in the Pacific Naval Laboratory on the west coast in Victoria, BC, but continued to be located at BIO until it moved to the Institute of Ocean Sciences in 1978. The Current Section was divided into two parts. The Current Studies Group was placed under Dr. C. R. Mann, Senior Oceanographer, while Inshore Tidal and Current Surveys was retained within the Hydrographic Group.

The research program was now organized as follows:

Department of Mines and Technical Surveys
Marine Sciences Branch Support Program

- Administration
- Engineering Services
- Oceanographic Services
- Ships

Marine Sciences Branch Research and Technical Surveys

- Oceanographic Research (included Marine Geophysics)
- Hydrographic Group
- Marine Geology
- Instrument Design Group

Department of Fisheries and Forestry
Fisheries Research Board of Canada

Atlantic Oceanographic Group

- Physical Oceanography
- Geology and Geochemistry
- Biological Oceanography
- Chemical Oceanography

Senior staff were now:

- L.A.E. Doe, Acting Director
- R.C. Melanson, Regional Hydrographer
- C.R. Mann, Senior Oceanographer
- R.L.G. Gilbert, Engineer-in-Charge
- B.R. Pelletier, Head of Marine Geology
- A.M. Holler, Marine Superintendent
- S.H. Scott, Administrative Officer
- R.W. Trites, Oceanographer-in-Charge of the Atlantic Oceanographic Group

1965

Dr. William L. Ford assumed the position of Director of the Marine Sciences Branch component at the Institute and hence became the overall director of BIO. The following quote from the Annual Review emphasized the uniqueness of BIO at that time.

"The Bedford Institute of Oceanography, now in its fourth year, may be viewed as a promising experiment in the organization of resources for marine research. The activities of BIO form part of a broad national program coordinated by the Canadian Committee on Oceanography, on which eight agencies of the Federal Government and four universities are represented. The Institute is housed on one campus and, in varying degrees, integrates several organizations which previously had operated more or less in isolation from one another."

The Atlantic Oceanographic Group (AOG) became an independent Fisheries Research Board of Canada (FRBC) laboratory reporting directly to the Chair of FRBC in Ottawa. Dr. Lloyd M. Dickie was appointed Director. This marked the beginning of an expanded program to study processes underlying marine production with special reference to fisheries. Like other FRBC laboratories across the country, this laboratory had its own director, program, administration and support services.

Mr. S.W. Howell became the Regional Marine Superintendent.

The Standards Laboratory was established to provide maintenance and calibration services for all electronic equipment in use at BIO and aboard ships.

The research program was now organized as follows:

Department of Mines and Technical Surveys
Marine Sciences Branch:

- Oceanographic Research (included Marine Geophysics)
- Marine Geology
- Micropalaeontology
- Hydrography
- Engineering Services
- Ships
- Administration

Department of Fisheries and Forestry
Fisheries Research Board of Canada
Atlantic Oceanographic Group:

- Biological Oceanography
- Environmental Oceanography

Senior staff were now:

- W.L. Ford, Director
- L.A.E. Doe, Senior Oceanographer

- R.L.G. Gilbert, Engineer-in-Charge
- S.W. Howell, Regional Marine Superintendent
- R.C. Melanson, Regional Hydrographer
- B.R. Pelletier, Head of Marine Geology
- S.H. Scott, Administrative Officer
- L.M. Dickie, Director of the Atlantic Oceanographic Group

1966

The Department of Mines and Technical Surveys (DMTS) became the Department of Energy Mines and Resources (DEMR). The Atlantic Oceanographic Group (AOG) was renamed the Dartmouth Laboratory of the Fisheries Research Board of Canada. A new section of Applied Oceanography was created with staff from both the Marine Sciences Branch (MSB) and AOG to pool the resources of a number of small groups working on practical problems. It was headed by Dr. Ronald W. Trites. The Ocean Circulation Group under Dr. Cedric R. Mann was also formed. The Engineering Services Section was divided into Metrology, which was responsible for the research, design and development of specialized oceanographic instrumentation, and Engineering Services, which was responsible for general engineering support functions. Metrology was headed by Dr. Reginald L.G. Gilbert and Engineering Services was headed by Mr. A.S. Atkinson. The Fisheries Oceanography Division was created and headed by Dr. Juri E. Paloheimo.

The research program was now organized as follows:

Department of Energy, Mines and Resources
Marine Sciences Branch (W.L. Ford, Director)

- Oceanographic Research (C.D. Maunsell) (included Marine Geophysics)
- Applied Oceanography (R.W. Trites)
- Marine Geology (B.R. Pelletier)
- Hydrography (R.C. Melanson)
- Metrology (R.L.G. Gilbert)
- Engineering Services (A. S. Atkinson)
- Ships (S.W. Howell)
- Administration (S.H. Scott)

Department of Fisheries and Forestry
Fisheries Research Board of Canada

Dartmouth Laboratory (L.M. Dickie, Director)

- Environmental Oceanography (R.W. Trites)
- Biological Oceanography (R.J. Conover)
- Fisheries Oceanography (J.E. Paloheimo)
- Administration (M.F. Blaxland)

1968

BIO was renamed the Bedford Institute. The Marine Sciences Branch laboratory, under the Department of Energy, Mines and Resources (DEMR), became the Atlantic Oceanographic Laboratory (AOL) with Dr. William L. Ford continuing as Director. The Dartmouth Laboratory of the Fisheries Research Board of Canada, under the Department of Fisheries and Forestry (DFF), became the Marine Ecology Laboratory (MEL) with Dr. Lloyd M. Dickie continuing as Director. The responsibility of the Ellerslie field station on PEI was transferred from St. Andrews to MEL.

The Population Dynamics Division was created and headed by Dr. Barry S. Muir. The Oyster and General Estuarine Ecology Division was also created and headed by Mr. Roy Drinnan.

The research program was now organized as follows:

Department of Energy, Mines and Resources
Marine Sciences Branch
Atlantic Oceanographic Laboratory (W.L. Ford, Director)

- Oceanographic Research Division (C.D. Maunsell) (included Marine Geophysics)
- Applied Oceanography Division (R.W. Trites)
- Marine Geology Division (B.R. Pelletier)
- Hydrography (R.C. Melanson)
- Metrology Division (R.L.G. Gilbert)
- Engineering Services (A.S. Atkinson)
- Ships (S.W. Howell)
- Administrative Services (S.H. Scott)
- Personnel (P.H. Sutherland)

Department of Fisheries and Forestry
Fisheries Research Board of Canada
Marine Ecology Laboratory (L.M. Dickie, Director)

- Environmental Oceanography Division (R.W. Trites)
- Biological Oceanography Division (K.H. Mann)
- Fisheries Oceanography Division (S.A. Paulowich)
- Population Dynamics Division (B.S. Muir)
- Oyster and General Estuarine Ecology Division (R. Drinnan)
- Administration (M.F. Blaxland)

1969

Dr. John Weir took over from Dr. F. Ronald Hayes as the Chairman of the Fisheries Research Board of Canada under the Department of Fisheries and Forestry in Ottawa.

Dr. Lloyd M. Dickie was loaned to the Science Council of Canada to undertake a study of marine science and technology in Canada in collaboration with Dr. Robert W. Stewart of the University of British Columbia.

1970

Recognizing the need for research on the quality of the marine environment, two pollution units were established within the Fisheries Research Board of Canada. The Atlantic unit was incorporated into the Marine Ecology Laboratory (MEL) and became the Environmental Quality Division headed by Dr. Donald C. Gordon that was housed in the newly expanded trailer complex north of the Fish Laboratory. The Pacific unit was set up in West Vancouver, BC, and became the Pacific Environment Institute headed by Dr. Michael Waldichuk.

A group of scientists from the Resource Development Branch of the Atlantic Fisheries Service, Department of Fisheries and Forestry, was established to investigate applied pollution issues and headed by Dr. Robert H. Cook.

The Chemical Oceanography Division was established in the Atlantic Oceanographic Laboratory (AOL) and headed by Dr. Alan Walton. The Marine Geophysics Division was also created and headed by Dr. David I. Ross.

The Scientific Services and Special Projects Division incorporating Computing, Scientific Information and Library Services was established in the Atlantic Oceanographic Laboratory (AOL) and headed by Dr. Charles D. Maunsell.

The Resource Management and Conservation Branch of the Department of Energy, Mines and Resources (DEMR) was established to curate drilling samples and data collected by the oil and gas industry.

The research program was now organized as follows:

Department of Energy, Mines and Resources
Marine Sciences Branch
Atlantic Oceanographic Laboratory (W.L. Ford, Director)

- Chemical Oceanography Division (A. Walton)
- Coastal Oceanography Division (R.W. Trites)
- Marine Geology Division (B.R. Pelletier)
- Marine Geophysics Division (D.I. Ross)
- Metrology Division (R.L.G. Gilbert)
- Ocean Circulation Division (C.R. Mann)
- Hydrography (R. Melanson)
- Scientific Services and Special Projects (C.D. Maunsell)
- Engineering Services (A.S. Atkinson)
- Ships (S.W. Howell)
- Administrative Services (S.H. Scott)
- Personnel (P.H. Sutherland)

Resource Management and Conservation Branch, Operations Division, East Coast Office (T.W. Dexter)

Department of Fisheries and Forestry
Fisheries Research Board of Canada of Canada
Marine Ecology Laboratory (L.M. Dickie, Director)

- Biological Oceanography Division (K.H. Mann)
- Environmental Oceanography Division (R.W. Trites)
- Population Studies Division (B.S. Muir)
- Fisheries Oceanography Division (P.C. Beamish)
- Environmental Quality Division (D.C. Gordon)
- Administration (M.F. Blaxland)

Atlantic Fisheries Service
Resource Development Branch

- Water Quality Unit (R.H. Cook)

1971

In Ottawa, Dr. William M. Cameron stepped down as Director of the Marine Sciences Branch and was replaced by Dr. Arthur E. Collin (who had been a research scientist at BIO when it opened and the Dominion Hydrographer since 1967).

The name of the Institute was changed back to the Bedford Institute of Oceanography.

The federal government created the Department of the Environment. This new department incorporated the Marine Ecology Laboratory (MEL), still part of the Fisheries Research Board of Canada, and most of the Atlantic Oceanographic Laboratory (AOL), still part of the Marine Sciences Branch (MSB). However, the Marine Geology and Marine Geophysics Divisions of AOL remained with the Department of Energy, Mines and Resources (DEMR) under the Geological Survey of Canada (GSC). The vessels and their budgets were transferred to DOE with agreements in place to continue supporting DEMR programs.

The Canadian Wildlife Service (CWS) established its first seabird program for Arctic and Eastern Canada, and placed one research scientist at BIO to study the pelagic ecology of marine birds (Dr. R.G.B. Brown).

The Eastern Petroleum Geology Section of the Geological Survey of Canada (GSC) was formed and headed by Dr. Bruce V. Sanford. Part of the GSC Basin Analysis Group transferred to BIO from Calgary, AB.

1972

As a result of a Senate Special Committee on Science Policy report, chaired by Senator Maurice Lamontagne, the national Make or Buy Program was introduced to encourage collaboration between the federal research community and the private sector.

The Marine Geology and Marine Geophysics Divisions under the Geological Survey of Canada were combined to form the Atlantic Geoscience Centre (AGC). Dr. Bosko D. Loncarevic was appointed as the first director.

Technical Support Services was established in the Atlantic Oceanographic Laboratory (AOL) under Dr. Reginald L.G. Gilbert. Dr. Clive S. Mason took over as head of the Metrology Division. The Stable Isotope Laboratory was established. The Tidal Section was established within the Canadian Hydrographic Service (CHS) to direct tide, tidal current and water levels work in Atlantic Canada that had previously been conducted out of Ottawa.

The Environmental Protection Service (EPS) was created in the new Department of Environment and established an Environmental Quality Laboratory in the trailer complex and Fish Laboratory that was headed by Dr. Robert H. Cook. This unique laboratory consisted of analytical chemistry (Dr. Hari Samant, Head), microbiology (Mr. Amar Menon, Head) and aquatic toxicology (Mr. Ed Pessah, Head) facilities. Additional space was dedicated to staff responsible for biological monitoring and surveillance.

Dr. Gil Farmer took over as head of the Resource Development Branch (RDB) water quality unit.

After major changes in organization over the past two years, BIO was now organized as follows:

Department of Environment
Marine Sciences Directorate
Atlantic Oceanographic Laboratory (W.L. Ford, Director)

- Chemical Oceanography Division (A. Walton)
- Coastal Oceanography Division (R.W. Trites)
- Metrology Division (C.S. Mason)
- Ocean Circulation Division (C.R. Mann)
- Program Analysis and Project Coordination Division (C.D. Maunsell)
- Hydrography Division (R.C. Melanson)
- Administration (S.H. Scott)
- Personnel (P.H. Sutherland)
- Public Relations (C.E. Murray)
- Technical Services (R.L.G. Gilbert)
    - Ships (E.S. Smith)
    - Engineering Services (S.B. MacPhee)
    - Computing Services (M.T. Darwood)
    - Scientific Information Services and Library (H.B. Nicholls)
    - Drafting and Illustrations (J.R. Lord)
    - Photography (N.E. Fenerty)

Fisheries Research Board of Canada
Marine Ecology Laboratory (L.M. Dickie, Director)

- Biological Oceanography Division (K.H. Mann)
- Environmental Oceanography Division (R.W. Trites)

- Fisheries Oceanography Division (B.S. Muir)
- Environmental Quality Division (D.C. Gordon)
- Administration (M.F. Blaxland)

Atlantic Fisheries Service
Resource Development Branch

- Water Quality Unit (G. Farmer)

Environmental Protection Service

- Environmental Quality Laboratory (R. Côté)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (B.D. Loncarevic, Director)

- Eastern Petroleum Geology Division (B.V. Sanford)
- Marine Geology Division (B.R. Pelletier)
- Marine Geophysics Division (D.I. Ross)

Resource Management and Conservation Branch, Operations Division, East Coast Office (T.W. Dexter)

1973

This year marked the end of the Fisheries Research Board of Canada (FRBC) as the active research arm of the Canadian Fisheries Service. It was relieved of direct control over research programs and facilities and became a purely advisory body. This major change in policy and organization integrated fisheries research and fisheries development under senior line managers in the Department of Environment in Ottawa. While the previous FRBC laboratories retained their independence, their directors now reported to a new Assistant Deputy Minister of Fisheries and Marine Science, Mr. Ken Lucas, rather than the Chairman of the FRBC.

The Atlantic Oceanographic Laboratory (AOL) and the Marine Ecology Laboratory (MEL) became part of the new Fisheries and Marine Service (FMS).

1974

In the Atlantic Oceanographic Laboratory (AOL), the Program Analysis and Project Coordination Division was created and headed by Dr. C.D. Maunsell. Finance and Administration was now headed by Mr. R.P. Smith.

Dr. Lloyd M Dickie departed the Marine Ecology Laboratory (MEL) to chair the Department of Oceanography and Institute of Environmental Studies at Dalhousie University. Dr. Barry S. Muir became the Acting Director of MEL and Dr. Daniel M. Ware took over as head of the Fisheries Oceanography Division. A Social Science Research Division was established in MEL and led by Dr. R.D.S. MacDonald.

In the Atlantic Geoscience Centre (AGC), the Environmental Marine Geology Division was created and headed by Mr. D.E. Buckley. In addition, the Program Support Division was created and headed by Mr. K.S. Manchester.

The Secretariat of the International Commission for the Northwest Atlantic Fisheries (ICNAF) moved from BIO to 800 Windmill Road in Dartmouth.

BIO was now organized as follows.

Department of Environment
Fisheries and Marine Service
Atlantic Oceanographic Laboratory (W.L. Ford, Director)

- Chemical Oceanography Division (A. Walton)
- Coastal Oceanography Division (R.W. Trites)
- Metrology Division (C.S. Mason)
- Ocean Circulation Division (C.R. Mann)
- Program Analysis and Project Coordination Division (C.D. Maunsell)
- Hydrography (R.C. Melanson)
- Finance and Administration (R.P. Smith)
- Public Relations (C.E. Murray)
- Technical Services (R.L.G. Gilbert)
    - Computing (M.T. Darwood)
    - Drafting and Illustrations (J.R. Lord)
    - Engineering Services (S.B. MacPhee)
    - Photography (N.E. Fenerty)
    - Scientific Information Services and Library (H.B. Nicholls)
    - Ships (E.S. Smith)

Marine Ecology Laboratory (B.S. Muir, Acting Director)

- Biological Oceanography Division (T.C. Platt)
- Environmental Oceanography Division (R.W. Trites)
- Fisheries Oceanography Division (D.M. Ware)
- Environmental Quality Division (D.C. Gordon)
- Social Science Research Division (R.D.S. Macdonald)
- Administration (M.F. Blaxland)

Atlantic Fisheries Service
Resource Development Branch

- Water Quality Unit (G. Farmer)

Environmental Protection Service

- Environmental Quality Laboratory (R. Côté)
    - Analytical Lab (H. Samant)
    - Microbiology Lab (A. Menon)
    - Aquatic Toxicology Lab (E. Pessah)

- Environmental Monitoring (R.C.H. Wilson)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (B.D. Loncarevic, Director)

- Eastern Petroleum Geology Division (L.P. Purcell)
- Environmental Marine Geology Division (D.E. Buckley)
- Regional Reconnaissance Division (D.I. Ross)
- Program Support (K.S. Manchester)
- Administration (R.A. Eden)

Resource Management and Conservation Branch, Operations Division, East Coast Office (T.W. Dexter)

1975

Dr. Barry S. Muir departed BIO to become the Director of the newly created Fisheries Resource Branch located in the Hollis Building in Halifax. Dr. Donald C. Gordon became Acting Director of the Marine Ecology Laboratory (MEL).

Dr. Bernie R. Pelletier departed BIO to join the Terrain Sciences Division of the Geological Survey of Canada (GSC) in Ottawa.

The coal petrology laboratory of the Geological Survey of Canada (GSC) moved from Calgary to become part of the Atlantic Geoscience Centre (AGC).

1976

The Department of Environment was renamed the Department of Fisheries and Environment and the Honourable Roméo LeBlanc was appointed Minister.

There were major changes in the organization of the Fisheries and Marine Service. The principal parts of the former fisheries operations organization, most of the previous Fisheries Research Board of Canada laboratories and the Resource Development Branch were placed in the new Fisheries Resource Branch while the remaining elements, including the Marine Ecology Laboratory (MEL), were assigned to Ocean and Aquatic Sciences (OAS), formerly the Marine Sciences Branch. A degree of decentralization from Ottawa was achieved by the appointment of regional Directors-General responsible to the Assistant Deputy Minister for OAS in Ottawa. Dr. William L. Ford was appointed as the regional DG and Dr. Arthur E. Collin became the ADM in Ottawa. Dr. Cedric R. Mann replaced Dr. William L. Ford as Director of the Atlantic Oceanographic Laboratory (AOL) and Dr. Trevor C. Platt became Acting Director of the Marine Ecology Laboratory (MEL).

As a result of these organizational changes, some MEL functions were transferred to the Fisheries Resource Branch. These included the management of a project developing acoustic methods for fisheries stock assessment, the shellfish aquaculture program and the operation of the research station at Ellerslie, PEI.

Institute-wide technical support functions, previously managed under the Atlantic Oceanographic Laboratory (AOL), became Institute Facilities managed by Dr. Reginald L.G. Gilbert.

In the Atlantic Oceanographic Laboratory (AOL), Dr. Clive S. Mason took over as head of Coastal Oceanography, Dr. George T. Needler took over as head of Ocean Circulation and Dr. David L. McKeown became head of Metrology. The Environmental Oceanography Division, which had overlapped AOL and MEL, was dissolved and staff transferred to either the Fisheries Oceanography Division in MEL or the Coastal Oceanography Division in AOL. AOL's Air-Sea Interaction Group was transferred from the Metrology Division to the Ocean Circulation Division. The Canadian Hydrographic Service (CHS) began the transfer of cartographic functions from Ottawa to BIO.

In MEL, Dr. Richard F. Addison became the head of Environmental Quality and Dr. Raymond W. Sheldon became the head of Fisheries Oceanography.

The Marine Fish Division, headed by Dr. Ralph G. Halliday, was created under the Fisheries Resource Branch based in the Hollis Building in Halifax and began setting up new staff at BIO. In addition, the Seabird Research Unit of the Canadian Wildlife Service (CWS), headed by Dr. David N. Nettleship, moved into BIO from Ottawa.

The Institute continued to function as one community sharing many common facilities and managed by a committee comprised of the regional DG, the three directors (AOL, MEL, AGC) and the Manager of Institute Facilities. This committee later expanded and became known as the Tuesday Club because it met regularly on Tuesday.

BIO was now organized as follows:

Department of Fisheries and Environment
Ocean and Aquatic Sciences (W.L. Ford, Regional Director-General)

Atlantic Oceanographic Laboratory (C.R. Mann, Director)
- Chemical Oceanography Division (A. Walton)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (G.T. Needler)
- Hydrography (R.C. Melanson)
- Finance and Administration (G.C. Bowdridge)
- Scientific Consultation (C.D. Maunsell)
- Public Relations (C.E. Murray)

Marine Ecology Laboratory (D.C. Gordon/T.C. Platt, Acting Director)
- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (R.F. Addison)

- Equipment Development Division (S.A. Paulowich)
- Fisheries Oceanography Division (R.W. Sheldon)
- Administration (M.F. Blaxland)

Institute Facilities (R.L.G. Gilbert, Manager)
- Ships (E.S. Smith)
- Engineering Services (D.F. Dinn)
- Computing Services (A. McEwan)
- Library Services (A. Nevill)
- Drafting and Illustrations (J.R. Lord)
- Photography (N.E. Fenerty)
- Scientific Editor (M.P. Latrémouille)

Fisheries Resource Branch
- Water Quality Unit (G. Farmer)
- Marine Fish Division (R.G. Halliday)

Environmental Protection Service
- Environmental Quality Laboratory (H. Samant)
    - Analytical Lab (R.A.F Matheson)
    - Microbiology Lab (A. Menon)
    - Aquatic Toxicology Lab (E. Pessah, P.G. Wells)
    - Environmental Monitoring (R.C.H. Wilson, D.A. Lord)

Canadian Wildlife Service (CWS)
- Seabird Research Unit (D.N. Nettleship)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (B.D. Loncarevic, Director)
- Eastern Petroleum Geology Division (L.P. Purcell)
- Environmental Marine Geology Division (D.E. Buckley)
- Regional Reconnaissance Division (D.I. Ross)
- Program Support (K.S. Manchester)
- Administration (R. Eden)

Resource Management and Conservation Branch, Operations Division, East Coast Office (T.W. Dexter)

Private companies began using BIO facilities and the first to arrive on campus were:
- Huntec Project Seabed I Office
- Canadian Ocean Data System (CODS) Shore Base
- Hermes Electronic Ltd.

1977

Dr. Richard F. Addison was appointed Acting Director of the Marine Ecology Laboratory (MEL). Later in the year, Dr. A. R. Longhurst, former Deputy Director of the Institute for Marine Environmental Research, Plymouth, UK, arrived to become the full time Director of MEL.

Dr. Bosko D. Loncarevic resigned as Director of the Atlantic Geoscience Centre (AGC) to return to research. Mr. Dale E. Buckley served as interim director until Dr. Michael J. Keen arrived from Dalhousie University as the new Director.

Mr. Ed Pessah took over as head of the Environmental Protection Service (EPS) Environmental Quality Laboratory. Dr. P.G. Wells became Head of the Aquatic Toxicology Section, as well as Co-Lead of the Environment Canada Dispersant Testing Program with Mr. K.G. Doe.

The first Canadian Hydrographic Service cartographers arrived from Ottawa and over three years the unit expanded to 23 cartographers.

1978

During this year, the Institute of Ocean Sciences opened in Sidney, BC, and the Northwest Atlantic Fisheries Centre opened in St. John's, NL.

Dr. William L. Ford retired as the Director-General of Ocean and Aquatic Sciences Atlantic after 13 years as the leader of BIO. He was succeeded by Dr. Cedric R. Mann. Dr. George T. Needler became the new Director of the Atlantic Oceanographic Laboratory (AOL).

In the Atlantic Oceanographic Laboratory (AOL), Dr. J. Michael Bewers became the head of Chemical Oceanography and Dr. James A. Elliott became head of Ocean Circulation.

In the Atlantic Geoscience Centre (AGC), Mr. M. Barss became the head of Eastern Petroleum Geology and Dr. Richard T. Haworth became the head of Regional Reconnaissance.

The Resource Management and Conservation Branch of the Department of Energy Mines and Resources (DEMR) became responsible for coal drilling off Cape Breton. Staff from the Geological Survey of Canada Terrain Sciences Division in Ottawa joined the Atlantic Geoscience Centre.

The Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) was established by the Department of Fisheries and Environment as a forum for scientific debate on methodology and development of peer-reviewed fisheries scientific advice for the Maritimes, Newfoundland and Quebec Regions. Its Secretariat, headed by Ms. Diane Geddes, was established at BIO under the Marine Fish Division.

Publication Services was established to facilitate and enhance BIO's publication effort and headed by Mr. Michel Latrémouille. It was composed of the scientific information resources that were previously affiliated with the library, drafting and photographic services.

BIO was now organized as follows:

Department of Fisheries and Environment
Ocean and Aquatic Sciences, Atlantic (C.R. Mann, Regional Director-General)
- Program Analysis and Coordination (H.B. Nicholls)
- Public Relations (C.E. Murray)
- Management Services (G.C. Bowdridge)

Atlantic Oceanographic Laboratory (G.T. Needler, Director)
- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (J.A. Elliott)
- Hydrography (R.C. Melanson)
- Scientific Consultation (C.D. Maunsell)

Marine Ecology Laboratory (A.R. Longhurst, Director)
- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (R.F. Addison)
- Fisheries Oceanography Division (R.W. Sheldon)
- Administration (M.F. Blaxland)

Institute Facilities (R.L.G. Gilbert, Manager)
- Ships (E.S. Smith)
- Engineering Services (D.F. Dinn)
- Computing Services (A. McEwan)
- Library Services (A. Nevill)
- Publication Services (M.P. Latrémouille)

Fisheries Resource Branch
- Water Quality Unit (G. Farmer)
- Marine Fish Division (R.G. Halliday) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) (D. Geddes)

Canadian Wildlife Service
- Seabird Research Unit (D.N. Nettleship)

Environmental Protection Service
- Environmental Quality Laboratory (E. Pessah)
    - Analytical Lab (R.A.F Matheson)
    - Microbiology Lab (A. Menon)

- Aquatic Toxicology Lab (P.G. Wells)
- Environmental Monitoring (D.A. Lord)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)

- Eastern Petroleum Geology Division (M.S. Barss)
- Environmental Marine Geology Division (D.E. Buckley)
- Regional Reconnaissance Division (R.T. Haworth)
- Program Support (K.S. Manchester)
- Administration (P.G. Stewart)

Resource Management and Conservation Branch, Operations Division, East Coast Office (T.W. Dexter)

1979

The Government Organization Act of 1979 split the Department of Fisheries and Environment (DFE) into the Department of Fisheries and Oceans (DFO) and the Department of Environment (DOE). The Honourable Romeo LeBlanc was appointed Minister of DFO. Both Ocean and Aquatic Surveys (OAS) Atlantic and the Fisheries Resource Branch became part of DFO. Other components of DFE became part of DOE.

The Fisheries Research Board of Canada (FRBC) was dissolved and staff transferred to DFO. The Fisheries Technological Program (E.G. Bligh, Director), based in Halifax, was terminated and the buildings were used to house elements of other DFO programs.

Ocean and Aquatic Sciences (OAS) became Ocean Science and Surveys (OSS) and Mr. Gerry Ewing replaced Dr. Arthur E. Collin as Assistant Deputy Minister in Ottawa.

Dr. Cedric R. Mann departed BIO to become Director-General of OSS Pacific at the Institute of Ocean Sciences, Sidney, BC. He was succeeded by Dr. Alan R. Longhurst. Dr. Richard F. Addison became Acting Director of the Marine Ecology Laboratory (MEL).

Mr. Adam J. Kerr was appointed Director of the Canadian Hydrographic Service (CHS) for the Atlantic Region at BIO.

1980

The Marine Advisory and Industrial Liaison Office (BIOMAIL) was created and headed by Mr. John Brooke. The BIOMAIL Office was intended to provide a point of entry for anyone seeking information on Canadian oceanography and related topics, to promote close relations between industry and BIO and to facilitate the transfer of technology.

Dr. Donald C. Gordon replaced Dr. Richard F. Addison as Acting Director of the Marine Ecology Laboratory (MEL) and served in this capacity until Dr. Kenneth H. Mann returned from Dalhousie to become full time Director.

Within the Environmental Protection Service, Dr. Hari Samant became Head of the Analytical Chemistry Section and the Aquatic Toxicity Section was now led by Mr. W.R. Parker. The monitoring group was disbanded.

The Northwest Atlantic Fisheries Organization (NAFO) was created to replace the International Council for North Atlantic Fisheries (ICNAF). It was headed by Capt. J.C.E. Cardoso and the headquarters was established at BIO.

1981

The Canada Oil and Gas Lands Administration (COGLA), under the Department of Energy, Mines and Resources (DEMR), established an Atlantic Regional Office at BIO that incorporated the previous Resource Management and Conservation Branch.

In the Atlantic Geoscience Centre (AGC), Dr. Graham L. Williams became head of Eastern Petroleum Geology and Dr. David J.W. Piper became head of Environmental Marine Geology.

Dr. Hari S. Samant became the head of the Environmental Protection Service (EPS) Environmental Quality Laboratory.

BIO was now organized as follows:

Department of Fisheries and Oceans
Ocean Science and Surveys, Atlantic (A.R. Longhurst, Regional Director-General)

- Program Analysis and Coordination (H.B. Nicholls)
- Public Relations (C.E. Murray)
- BIOMAIL (J. Brooke)
- Management Services (G.C. Bowdridge)
- Personnel Services (J.G. Feetham)

Atlantic Oceanographic Laboratory (G.T. Needler, Director)

- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (J.A. Elliott)

Atlantic Region, Canadian Hydrographic Service (A.J. Kerr, Director)

- Field Surveys (T.B. Smith)
- Chart Production (R.F.J. Gervais)
- Hydrographic Development (R.G. Burke)
- Navigation (R.M. Eaton)
- Planning and Records (R.C. Lewis)

- Tidal (D.L. DeWolfe)

Marine Ecology Laboratory (K.H. Mann, Director)

- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (R.F. Addison)
- Fisheries Oceanography Division (R.W. Sheldon)

Institute Facilities (R.L.G. Gilbert, Manager)

- Ships (E.S. Smith)
- Engineering Services (D.F. Dinn)
- Computing Services (D.M. Porteous)
- Library Services (J.E. Sutherland)
- Publication Services (M.P. Latrémouille)

Fisheries Resource Branch

- Marine Fish Division (R.G. Halliday) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)

- Eastern Petroleum Geology Division (G.L. Williams)
- Environmental Marine Geology Division (D.J.W. Piper)
- Regional Reconnaissance Division (R.T. Haworth)
- Program Support (K.S. Manchester)
- Administration (P.G. Stewart)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service

- Seabird Research Unit (D.N. Nettleship)

Environmental Protection Service

- Environmental Quality Laboratory (H.S. Samant)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Capt. J.C.E. Cardoso)

The following marine science-related private companies now leased accommodations on the BIO campus:

- Huntec Ltd.
- Wycove Systems Ltd.
- Franklin Computers Ltd.

1982

A separate Gulf Region was created in the Department of Fisheries and Oceans. This produced a major reorganization of the research programs at BIO, the Halifax Fisheries Research Laboratory, the St. Andrews Biological Station and the new Gulf Fisheries Centre in Moncton, NB as well as the resource management mandates between the Scotia Fundy and new Gulf Regions.

The Ocean Information Division was formed and headed by Mr. Brian Nicholls. Dr. Derrick Iles became head of the Marine Fish Division (MFD).

BIO was now organized as follows:

Department of Fisheries and Oceans
Ocean Science and Surveys, Atlantic (A.R. Longhurst, Regional Director-General)

- Ocean Information Division (H.B. Nicholls)
- Public Relations (C.E. Murray)
- BIOMAIL (G.R. Smith)
- Management Services (G.C. Bowdridge)
- Personnel Services (J.G. Feetham)

Atlantic Oceanographic Laboratory (G.T. Needler, Director)

- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (J.A. Elliott)

Canadian Hydrographic Service (Atlantic Region) (A.J. Kerr, Director)

- Field Surveys (T.B. Smith)
- Chart Production (B.E. McCorriston)
- Hydrographic Development (R.G. Burke)
- Navigation (R.M. Eaton)
- Planning and Records (R.C. Lewis)
- Tidal (D.L. DeWolfe)

Marine Ecology Laboratory (K.H. Mann, Director)

- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (R.F. Addison)
- Fisheries Oceanography Division (R.W. Sheldon)

Institute Facilities (R.L.G. Gilbert, Manager)

- Ships (E.S. Smith)
- Engineering Services (D.F. Dinn)
- Computing Services (D.M. Porteous)

- Library Services (J.E. Sutherland)
- Publication Services (M.P. Latrémouille)

Fisheries Resource Branch

- Marine Fish Division (T.D. Iles) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)

- Eastern Petroleum Geology Division (G.L. Williams)
- Environmental Marine Geology Division (D.J.W. Piper)
- Regional Reconnaissance Division (R.T. Haworth)
- Program Support (K.S. Manchester)
- Administration (P.G. Stewart)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service

- Seabird Research Unit (D.N. Nettleship)

Environmental Protection Service

- Environmental Quality Laboratory (H.S. Samant)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Capt. J.C.E. Cardoso)

The following marine science-related private companies leased accommodations on the BIO campus:

- Huntec Ltd.
- Wycove Systems Ltd.
- Franklin Computers Ltd.

1983

This year marked the centennial of the Canadian Hydrographic Service (CHS).

Dr. Steven J. Kerr became the head of the Fisheries Oceanography Division.

Ocean Science and Surveys, Atlantic organized its environmental assessment and review activities under a special mechanism known as ENACT (ENvironmental Assessment Coordinating Team). The objectives of ENACT were to advise regional senior managers on environmental impact assessment and review and to coordinate regional activities in the field.

BIO was now organized as follows:

Department of Fisheries and Oceans
Ocean Science and Surveys, Atlantic (A.R. Longhurst, Regional Director-General)

- Ocean Information Division (H.B. Nicholls)
- Public Relations (C.E. Murray)
- BIOMAIL (G.R. Smith)
- Management Services (G.C. Bowdridge)
- Personnel Services (J.G. Feetham)

Atlantic Oceanographic Laboratory (G.T. Needler, Director)

- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (J.A. Elliott)

Canadian Hydrographic Service (Atlantic Region) (A.J. Kerr, Director)

- Field Surveys (T.B. Smith)
- Chart Production (S. Weston)
- Hydrographic Development (R.G. Burke)
- Navigation (R.M. Eaton)
- Planning and Records (R.C. Lewis)
- Tidal (S.T. Grant)

Marine Ecology Laboratory (K.H. Mann, Director)

- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (R.F. Addison)
- Fisheries Oceanography Division (S.J. Kerr)

Institute Facilities (R.L.G. Gilbert, Manager)

- Ships (E.S. Smith)
- Engineering Services (D.F. Dinn)
- Computing Services (D.M. Porteous)
- Library Services (J.E. Sutherland)
- Publication Services (M.P. Latrémouille)

Fisheries Resource Branch

- Marine Fish Division (W. Stobo) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)

- Eastern Petroleum Geology Division (G.L. Williams)
- Environmental Marine Geology Division (D.J.W. Piper)

- Regional Reconnaissance Division (R.T. Haworth)
- Program Support (K.S. Manchester)
- Administration (P.G. Stewart)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service

- Seabird Research Unit (D.N. Nettleship)

Environmental Protection Service

- Environmental Quality Laboratory (H.S. Samant)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Capt. J.C.E. Cardoso).

The following marine science-related private companies leased accommodations on the BIO campus:

- Huntec Ltd.
- Wycove Systems Ltd.
- Franklin Computers Ltd.

1984

Dr. George T. Needler departed BIO to become Director of the International Planning Office for the World Ocean Climate Experiment (WOCE) in London, UK. He was replaced as Director of the Atlantic Oceanographic Laboratory (AOL) by Dr. James A. Elliott while Dr. R. Allyn Clarke became head of Ocean Circulation. Dr. W. Donald Bowen became head of the Marine Fish Division and Dr. Charlotte E. Keen became head of Regional Reconnaissance.

BIO was now organized as follows:

Department of Fisheries and Oceans
Ocean Science and Surveys, Atlantic (A.R. Longhurst, Regional Director-General)

- Ocean Information Division (H.B. Nicholls)
- BIOMAIL (B. Bennett)
- Public Relations (C.E. Murray)
- Management Services (G.C. Bowdridge)
- Personnel Services (J.G. Feetham)

Atlantic Oceanographic Laboratory (J.A. Elliott, Director)

- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)

- Ocean Circulation Division (R.A. Clarke)

Canadian Hydrographic Service (Atlantic Region) (A.J. Kerr, Director)
- Field Surveys (R.C. Lewis)
- Chart Production (S.L. Weston)
- Hydrographic Development (R.G. Burke)
- Navigation (R.M. Eaton)
- Planning and Records (R.C. Lewis)
- Tidal (S.T. Grant)

Marine Ecology Laboratory (K.H. Mann, Director)
- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (R.F. Addison)
- Fisheries Oceanography Division (S.J. Kerr)

Institute Facilities (R.L.G. Gilbert, Manager)
- Ships (J. Parsons)
- Engineering Services (D.F. Dinn)
- Computing Services (D.M. Porteous)
- Library Services (J.E. Sutherland)
- Publication Services (M.P. Latrémouille)

Fisheries Resource Branch
- Marine Fish Division (W.D. Bowen) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)
- Eastern Petroleum Geology Division (G.L. Williams)
- Environmental Marine Geology Division (D.J.W. Piper)
- Regional Reconnaissance Division (C.E. Keen)
- Program Support (K.S. Manchester)
- Administration (C. Racine)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service
- Seabird Research Unit (D.N. Nettleship)

Environmental Protection Service
- Environmental Quality Laboratory (H.S. Samant)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Capt. J.C.E. Cardoso).

The following marine science-related private companies occupied leased accommodations on the BIO campus:

- Huntec Ltd.
- Wycove Systems Ltd.
- Franklin Computers Ltd.

1985

In the Marine Ecology Laboratory (MEL), Dr. Donald C. Gordon became head of the Fisheries Oceanography Division and Dr. Barry T. Hargrave became the head of the Environmental Quality Division. In the Atlantic Geoscience Centre (AGC), Dr. J.S. Bell became head of Eastern Petroleum Geology.

BIO was now organized as follows:

Department of Fisheries and Oceans
Ocean Science and Surveys, Atlantic (A.R. Longhurst, Regional Director-General)

- Ocean Information Division (H.B. Nicholls)
- Public Relations (C.E. Murray)
- Management Services (G.C. Bowdridge)
- Personnel Services (J.G. Feetham)

Atlantic Oceanographic Laboratory (J.A. Elliott, Director)

- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (R.A. Clarke)

Canadian Hydrographic Service (Atlantic Region) (A.J. Kerr, Director)

- Field Surveys (R.C. Lewis)
- Chart Production (T.B. Smith)
- Hydrographic Development (R.G. Burke)
- Navigation (R.M. Eaton)
- Planning and Records (R.C. Lewis)
- Tidal (S.T. Grant)

Marine Ecology Laboratory (K.H. Mann, Director)

- Biological Oceanography Division (T.C. Platt)
- Environmental Quality Division (B.T. Hargrave)
- Fisheries Oceanography Division (D.C. Gordon)

Institute Facilities (R.L.G. Gilbert, Manager)

- Ships (J. Parsons)
- Engineering Services (D.F. Dinn)
- Computing Services (D.M. Porteous)
- Library Services (J.E. Sutherland)
- Publication Services (M.P. Latrémouille)

Fisheries Resource Branch

- Marine Fish Division (W.D. Bowen) which included the Canadian Atlantic Fisheries Scientific Advisory Committee) Secretariat (D. Geddes)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)

- Eastern Petroleum Geology Division (J.S. Bell)
- Environmental Marine Geology Division (D.J.W. Piper)
- Regional Reconnaissance Division (C.E. Keen)
- Program Support (K.S. Manchester)
- Administration (C. Racine)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service

- Seabird Research Unit (D.N. Nettleship)

Environmental Protection Service

- Environmental Quality Laboratory (H.S. Samant)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Capt. J.C.E. Cardoso).

The following marine science-related private companies occupied leased accommodations on the BIO campus:

- Huntec Ltd.
- Wycove Systems Ltd.
- Franklin Computers Ltd.

1986

The Gulf Fisheries Centre officially opened in Moncton, NB.

This year marked the beginning of major top-down changes in the national organization of the Department of Fisheries and Oceans (DFO) that had a profound impact on BIO. Those in control in Ottawa were the Honourable Tom Siddon, Minister of DFO, Mr. Peter Meyboom, Deputy Minister, and Dr. Scott Parsons, Assistant Deputy Minister of Science. The decision was made to disband Ocean Science and Surveys (OSS) and integrate it with the Fisheries Research Branch in all regions across the country. The Scotia-Fundy Region of DFO was created and Mr. J.-E. Haché was appointed as Regional Director General.

At BIO, the position of Director-General, OSS Atlantic, was terminated and Dr. Alan R. Longhurst moved to the Biological Oceanography Division as a research scientist. The position of Regional Director of Science for the Scotia-Fundy Region was created and filled on an acting basis by Dr. Barry S. Muir from Ottawa. This lower level position of Regional Director of Science reported to the Regional Director-General, a change that marked the end of direct reporting to Ottawa for BIO oceanography programs.

As part of this reorganization, the St. Andrews Biological Station and the Halifax Fisheries Research Laboratory also lost their status as independent labs and their scientific staff now reported to the new Regional Director of Science at BIO. Some Marine Ecology Laboratory (MEL) staff transferred to the Newfoundland Region.

The new DFO Fish Habitat Policy became operational and called for increased collaboration between habitat managers and scientists.

1987

The DFO Maurice Lamontagne Institute opened in Mont-Joli, QC, and initiated oceanographic research programs in the Quebec Region, including the Gulf of St. Lawrence.

BIO celebrated its 25th anniversary. In attendance at the commemorative ceremony on 25 October were the Lieutenant-Governor of Nova Scotia, the Premier of Nova Scotia, the Mayors of Halifax and Dartmouth, the Deputy Minister and the Assistant Deputy Minister of Department of Fisheries and Oceans and the President of Dalhousie University.

Major changes in the organization of BIO continued. The Marine Ecology Laboratory (ME) was officially disbanded after 22 years of marine ecological research. While the Biological Oceanography Division remained intact, the Environmental and Fisheries Oceanography Divisions were dissolved and staff dispersed on the basis of discipline to other divisions in either the new Biological Sciences Branch (BSB) or the new Physical and Chemical Sciences Branch (PCSB). The Atlantic Oceanographic Laboratory (AOL) ceased to exist in name but its four divisions remained intact under the new PCSB. Dr. James A. Elliott was appointed Director of PCSB and Dr. James E. Stewart was appointed Director of BSB. The new PCSB and BSB also included staff at the Halifax Fisheries Research Laboratory and the St. Andrews Biological Station. Dr. Barry S. Muir returned to Ottawa and Mr. Steven B. MacPhee was appointed as the new DFO Regional Director of Science. The Canadian Hydrographic Service (CHS) became a separate branch under the Regional Director of Science. The CSS *Maxwell* and seven CHS staff were transferred to St. John's, NL, to set up a regional office. The Marine Assessment and Liaison Division (MALD) was formed to facilitate collaboration between DFO Science and Habitat Management and headed by Mr. H. Brian Nicholls.

Mr. Adam J Kerr, Regional Director CHS Atlantic, was elected to a 5-year term as Director of the International Hydrographic Organization in Monaco.

Dr. Eric H.J. Hiscock became head of the Seabird Research Unit.

Due to cuts in funding, scientists were now being encouraged to seek external financial support. The era of science-driven research in federal laboratories was largely over and scientists had to pay more attention to addressing the needs of fisheries and habitat managers, other government agencies and industry. Increasing emphasis was placed on developing partnerships.

Sector management was introduced. Non-scientific functions were removed from under the control of the science directors and placed in new separate management branches: the Management Services Branch and the Comptroller's Branch. This move increased the administrative burden and placed substantial resources under the control of non-scientists. The Tuesday Club expanded to include the new managerial positions.

After these major and disruptive changes in DFO, BIO was now organized as follows:

Department of Fisheries and Oceans
Scotia-Fundy Region
Regional Director-General (J.-E. Haché) (Hollis Building)

Regional Director Science (S.B. MacPhee)
- Marine Assessment and Liaison Division (H.B. Nicholls)

Biological Sciences Branch (J.E. Stewart, Director) (Hollis Building)
- Marine Fish Division (W.D. Bowen) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)
- Invertebrates, Plants and Environmental Ecology Division (M.M. Sinclair) (Halifax Fisheries Research Laboratory)
- Biological Oceanography Division (T.C. Platt)
- Enhancement, Culture and Anadromous Fisheries Division (N.E. MacEachern) (Hollis Building)
- Fish Aquaculture and Applied Physiology (R.H. Cook) (St. Andrews Biological Station)

Physical and Chemical Sciences Branch (J.A. Elliott, Director)
- Chemical Oceanography Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (R.A. Clarke)

Hydrography Branch, Canadian Hydrographic Service (Atlantic) (A.J. Kerr, Director)
- Field Surveys (T.B. Smith)
- Chart Production (S.L. Weston)
- Hydrographic Development (R.G. Burke)
- Navigation (R.M. Eaton)

- Data Management and Planning (R.C. Lewis)
- Tidal (S.T. Grant)

Management Services Branch (E.J. Maher, Manager)
- Marine Services (J.H. Parsons)
- Engineering and Technical Services (D.F. Dinn)
- Library Services (J.E. Sutherland)
- Administrative Services (J. Broussard)

Comptroller's Branch (G.C. Bowdridge, Manager)
- Accounting and Treasury Operations (S. Lucas)
- Financial Planning and Analysis (L.Y. Seto)
- Operational Work Planning (R.A. Higgins)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)
- Eastern Petroleum Geology Division (M.E. Best)
- Environmental Marine Geology Division (D.J.W. Piper)
- Regional Reconnaissance Division (C.E. Keen)
- Program Support (K.S. Manchester)
- Administration (C. Racine)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service
- Seabird Research Unit (E.H.J. Hiscock)

Environmental Protection Service
- Environmental Quality Laboratory (H.S. Samant)
    - Analytical Lab (R.A.F Matheson)
    - Microbiology Lab (A. Menon)
    - Aquatic Toxicology Lab (K.G. Doe)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Captain J.C.E. Cardoso)

The following marine science-related industries now rented space at BIO:
- ASA Consulting Ltd.
- Brooke Ocean Technology
- Seakem Oceanography
- Seastar Instruments Ltd.
- Seimac Ltd.

1988

The fine-tuning of the new DFO organization continued. Dr. Michael M. Sinclair was appointed as Director of the Biological Sciences Branch (BSB). The Habitat Ecology Division was created and headed by Dr. Donald C. Gordon. It reunited numerous staff that had been part of the Marine Ecology Laboratory (MEL). Mr. Adam Kerr retired and Mr. Paul Bellemare was appointed Regional Director of Hydrography. A new Communications Branch was created and headed by Mr. J. Gough.

In the Atlantic Geoscience Centre (AGC), Mr. Robert Taylor became the acting head of Environmental Marine Geology and Mr. Ronald Macnab became the head of Regional Reconnaissance.

BIO was now organized as follows:

Department of Fisheries and Oceans
Scotia-Fundy Region
Regional Director-General (J.-E. Haché) (Hollis Building)

Regional Director of Science (S.B. MacPhee)
- Marine Assessment and Liasion Division (H.B. Nicholls)
- Scientific Computing Services (D. Porteus)

Biological Sciences Branch (M.M. Sinclair, Director)
- Marine Fish Division (W.D. Bowen) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)
- Invertebrates, Marine Plants and Environmental Ecology Division (J.D. Pringle) (Halifax Fisheries Research Laboratory)
- Biological Oceanography Division (T.C. Platt)
- Habitat Ecology Division (D.C. Gordon)
- Enhancement, Culture and Anadromous Fisheries Division (N.E. MacEachern) (Hollis Building)
- Fish Aquaculture and Applied Physiology Division (R.H. Cook) (St. Andrews Biological Station)

Physical and Chemical Sciences Branch (J.A. Elliott, Director)
- Marine Chemistry Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (R.A. Clarke)

Hydrography Branch, Canadian Hydrographic Service (Atlantic) (P. Bellemare, Director)
- Field Surveys (T.B. Smith)
- Chart Production (S.L. Weston)
- Hydrographic Development (R.G. Burke)

- Navigation (H. Boudreau)
- Data Management and Planning (R.C. Lewis)
- Tidal Section (S.T. Grant)

Management Services Branch (E.J. Maher, Director)
- Marine Services (J.H. Parsons)
- Engineering and Technical Services (D.F. Dinn)
- Facilities Management (A. Medynski)
- Material Management (G. Hewett)
- Information Systems (C. Elson)
- Library Services (J.E. Sutherland)
- Administrative Services (J. Broussard)

Comptroller's Branch (G.C. Bowdridge, Director)
- Accounting and Treasury Operations (S. Lucas)
- Financial Planning and Analysis (L.Y. Seto)
- Operational Work Planning (R.A. Higgins)

Communications Branch (J. Gough)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (M.J. Keen, Director)
- Eastern Petroleum Geology Division (M.E. Best)
- Environmental Marine Geology Division (R.B. Taylor)
- Regional Reconnaissance Division (R. Macnab)
- Program Support (K.S. Manchester)
- Administration (C. Racine)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Department of Environment
Canadian Wildlife Service
- Seabird Research Unit (E.H.J. Hiscock)

Environmental Protection Service
- Environmental Quality Laboratory (H.S. Samant)

BIO also housed the office of the North Atlantic Fisheries Organization (NAFO) (Captain J.C.E. Cardoso)

The following marine science-related industries were located at BIO:
- ASA Consulting Ltd.
- Brooke Ocean Technology

- Seakem Oceanography
- Seastar Instruments Ltd.
- Seimac Ltd.

1989

Dr. John A. Ritter took over as head of the Freshwater and Anadromous Division and Mr. Robert N. O'Boyle became the head of the Marine Fish Division.

Dr. D.I. Ross replaced Dr. M.J. Keen as Director of the Atlantic Geoscience Centre (AGC). Dr. David B. Prior became head of Environmental Marine Geology and Dr. Matt H. Salisbury became head of Regional Reconnaissance.

The Northwest Atlantic Fisheries Organization (NAFO) Secretariat moved to new offices on Wyse Road in Dartmouth.

BIO was now organized as follows:

Department of Fisheries and Oceans
Scotia-Fundy Region
Regional Director-General (J.-E. Haché) (Hollis Building)

Regional Director of Science (S.B. MacPhee)
- Marine Assessment and Liaison Division (H.B. Nicholls)
- Scientific Computing Services (D. Porteus)
- Ocean Technology Promotion (C. Clute)

Biological Sciences Branch (M.M. Sinclair, Director)
- Marine Fish Division (R.N. O' Boyle) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)
- Benthic Fisheries and Aquaculture Division (J.D. Pringle) (Halifax Fisheries Research Laboratory)
- Biological Oceanography Division (T.C. Platt)
- Habitat Ecology Division (D.C. Gordon)
- Freshwater and Anadromous Division (J.A. Ritter) (Hollis Building)
- Aquaculture and Invertebrate Fisheries Division (R.H. Cook) (St. Andrews Biological Station)

Physical and Chemical Sciences Branch (J.A. Elliott, Director)
- Marine Chemistry Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (R.A. Clarke)

Hydrography Branch, Canadian Hydrographic Service (Atlantic) (P. Bellemare, Director)

- Field Surveys (R.C. Lewis)
- Nautical Publications (S.L. Weston)
- Hydrographic Development (R.G. Burke)
- Data Management and Planning (S.T. Grant)
- Tidal Section (C. O'Rielly)

Management Services Branch (E.J. Maher, Director)
- Marine Services (W. Cottle)
- Engineering and Technical Services (D.F. Dinn)
- Facilities Management (A. Medynski)
- Material Management (J. Broussard)
- Information Systems (C. Crowe)
- Library Services (A. Oxley)
- Administrative Services (D. Brown)

Comptroller's Branch (G.C. Bowdridge, Director)
- Accounting and Treasury Operations (S. Lucas)
- Financial Planning and Analysis (L.Y. Seto)
- Operational Work Planning (R.A. Higgins)

Communications Branch (J. Gough)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (D.I. Ross, Director)
- Basin Analysis (M.E. Best)
- Environmental Marine Geology Division (D.B. Prior)
- Regional Reconnaissance Division (M.H. Salisbury)
- Program Support Division (K.S. Manchester)
- Administration (C. Racine)

Atlantic Regional Office of the Canada Oil and Gas Lands Administration (COGLA) (T.W. Dexter)

Environment Canada
Canadian Wildlife Service
- Marine Wildlife Conservation Division (E.H.J. Hiscock)

Environmental Protection Service
- Environmental Quality Laboratory (H. Samant)

The following marine science-related industries leased space at BIO:
- ASA Consulting Ltd.
- Brooke Ocean Technology
- Seakem Oceanography

- Seastar Instruments Ltd.

1991

Mr. Neil A. Bellefontaine became the Regional Director-General for the Scotia-Fundy Region of DFO.

In the Atlantic Geoscience Centre (AGC), Dr. K.D. MacAlpine became head of Basin Analysis and Dr. Jacob Verhoef became head of Regional Reconnaissance. The Canada Oil and Gas Lands Administration left BIO.

Mr. K.G. Doe became head of the Environment Canada Environmental Quality Laboratory.

BIO was now organized as follows:

Department of Fisheries and Oceans
Scotia-Fundy Region
Regional Director-General (N.A. Bellefontaine) (Hollis Building)

Regional Director of Science (S.B. MacPhee)
- Marine Assessment and Liaison Division (H.B. Nicholls)
- Scientific Computing Services (D. Porteus)

Biological Sciences Branch (M.M. Sinclair, Director)
- Marine Fish Division (R.N. O'Boyle) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)
- Benthic Fisheries and Aquaculture Division (J.D. Pringle) (Halifax Fisheries Research Laboratory)
- Biological Oceanography Division (T.C. Platt)
- Habitat Ecology Division (D.C. Gordon)
- Freshwater and Anadromous Division (J.A. Ritter) (Hollis Building)
- Aquaculture and Invertebrate Fisheries Division (R.H. Cook) (St. Andrews Biological Station)

Physical and Chemical Sciences Branch (J.A. Elliott, Director)
- Marine Chemistry Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)
- Ocean Circulation Division (R.A. Clarke)

Hydrography Branch, Canadian Hydrographic Service (Atlantic) (P. Bellemare, Director)
- Field Surveys (R.C. Lewis)
- Nautical Publications (S.L. Weston)
- Hydrographic Development (R.G. Burke)
- Data Management and Planning (S.T. Grant)

- Tides, Currents and Water Levels (C. O'Reilly)

Management Services Branch (E.J. Maher, Director)
- Marine Services (J. Wheelhouse)
- Engineering and Technical Services (D.F. Dinn)
- Facilities Management (A. Medynski)
- Material Management (J. Broussard)
- Information Systems Services (C. Crowe)
- Library Services (A.R. Fiander)
- Administrative Services (H.S. Leonard)

Comptroller's Branch (G.C. Bowdridge, Director)
- Accounting and Treasury Operations (S. Lucas)
- Financial Planning and Analysis (L.Y. Seto)

Communications Branch (J. Gough)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (D.I. Ross, Director)
- Basin Analysis (K.D. McAlpine)
- Environmental Marine Geology Division (D.B. Prior)
- Regional Reconnaissance Division (J. Verhoef)
- Program Support Division (K.S. Manchester)
- Administration (G. McCormack)

Environment Canada
Canadian Wildlife Service
- Marine Wildlife Conservation Division (E.H.J. Hiscock)

Environmental Protection Service
- Environmental Quality Laboratory (K.G. Doe)
    - Analytical Lab (O. Vaijda)
    - Microbiology Lab (C. Craig)
    - Aquatic Toxicology Lab (K.G. Doe)

The following marine science-related industries leased space at BIO:
- ASA Consulting Ltd.
- Brooke Ocean Technology
- Seakem Oceanography
- Seastar Instruments Ltd.

1992

Public Works and Government Services Canada took over the operation and maintenance of BIO facilities from the Department of Fisheries and Oceans.

Dr. David I. Ross resigned as Director of the Atlantic Geoscience Centre and moved to New Zealand. He was succeeded by Dr. David B. Prior. Dr. C.F. Michael Lewis became the head of Environmental Marine Geology until Dr. Richard A. Pickrill assumed the position.

1993

The DFO Regional Headquarters moved from the Hollis Building to the Maritime Centre in Halifax.

The DFO Aquaculture Coordination Office was created and headed by Dr. Robert H. Cook. Dr. Wendy Watson-Wright took over as Head of the St. Andrews Biological Station.

The Route Survey Office of the Department of National Defence (DND) was established to provide detailed seabed data to the Navy in support of surveillance and national security. The group was part of the Maritime Forces Atlantic's Joint Oceanographic Surveillance and Information Centre.

BIO was now organized as follows:

Department of Fisheries and Oceans
Scotia-Fundy Region
Regional Director-General (N.A. Bellefontaine) (Maritime Centre)

Regional Director Science (S.B. MacPhee)
- Marine Assessment and Liaison Division (H.B. Nicholls)
- Scientific Computing Services (D. Porteus)

Biological Sciences Branch (M.M. Sinclair, Director)
- Marine Fish Division (R.N. O'Boyle) which included the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) Secretariat (D. Geddes)
- Benthic Fisheries and Aquaculture Division (J.D. Pringle) (Halifax Fisheries Research Laboratory)
- Biological Oceanography Division (T.C. Platt)
- Habitat Ecology Division (D.C. Gordon)
- Freshwater and Anadromous Division (J.A. Ritter) (Maritime Centre)
- St. Andrews Biological Station (W. Watson-Wright) (St. Andrews Biological Station)

Physical and Chemical Sciences Branch (J.A. Elliott, Director)
- Marine Chemistry Division (J.M. Bewers)
- Coastal Oceanography Division (C.S. Mason)
- Metrology Division (D.L. McKeown)

- Ocean Circulation Division (R.A. Clarke)

Hydrography Branch, Canadian Hydrographic Service (Atlantic) (P. Bellemare, Director)
- Hydrographic Surveys (R.C. Lewis)
- Nautical Publications (S.L. Weston)
- Hydrographic Development (R.G. Burke)
- Data Management (S.T. Grant)

Aquaculture Coordination Office (R.H. Cook) (Maritime Centre)

Management Services Branch (J. Wheelhouse, Director)
- Marine Services (W. Cottle)
- Engineering and Technical Services (D.F. Dinn)
- Facilities Management (A. Medynski)
- Material Management (B. Tsinman)
- Information Systems Services (T. Wagg)
- Library Services (A.R. Fiander)
- Administrative Services (G. Browne)

Comptroller's Branch (G.C. Bowdridge, Director)
- Accounting and Treasury Operations (S. Lucas)
- Financial Planning and Analysis (L.Y. Seto)

Communications Branch (J. Gough)

Department of Energy, Mines and Resources
Geological Survey of Canada
Atlantic Geoscience Centre (D.B. Prior, Director)
- Basin Analysis (K.D. McAlpine)
- Environmental Marine Geology Division (R.A. Pickrill)
- Regional Reconnaissance Division (J. Verhoef)
- Program Support Division (K.S. Manchester)
- Administration (G. McCormack)

Environment Canada
Canadian Wildlife Service
- Marine Wildlife Conservation Division (E.H.J. Hiscock)

Environmental Protection Service
- Environmental Quality Laboratory (K.G. Doe)

Department of National Defence
Route Survey Office (J. Bradford)

The following marine science-related industries leased space at BIO:

- ASA Consulting Ltd.
- Brooke Ocean Technology Ltd.
- Geoforce Consultants Ltd.

1995

Significant changes, driven by a major program review of all federal government programs in Canada, were made in the organization of BIO. The Scotia-Fundy and Gulf Regions of the Department of Fisheries and Oceans were merged into a single Maritimes Region and Mr. Neil A. Bellefontaine was appointed Regional Director-General.

The Canadian Coast Guard moved from Transport Canada to become a special agency under the Department of Fisheries and Oceans. It took over the operation of the BIO research vessel fleet.

Mr. Steven B. MacPhee, Regional Science Director, moved to Ottawa to become Director-General of the Canadian Hydrographic Service and was replaced on an acting basis by Dr. James A. Elliott. The Biological Sciences Branch (BSB) and the Physical Chemical Sciences Branch (PCSB) were dissolved and staff merged under the Regional Science Director.

Staff from the previous PCSB divisions were merged to form the new Ocean Sciences Division headed by Dr. James A. Elliott. The Habitat Ecology and Marine Chemistry Divisions were merged to create the new Environmental Sciences Division. The initial head was Dr. John Pringle, who moved over to BIO from the Halifax Fisheries Research Laboratory, but soon after he was replaced by Mr. Paul D. Keizer.

The Canadian Forestry Service moved from Agriculture Canada to Energy, Mines and Resources Canada that was renamed Natural Resources Canada.

1996

Organizational and budgetary reductions decisions taken in 1995 began to take full effect. Reductions throughout the federal government under its Program Review meant an approximately 40% reduction in staff and financial resources in the DFO Maritimes Region Science Branch. Most of the impacts were felt in the first two fiscal years of the Program Review as many people accepted early retirement incentives. New staffing opportunities were scarce and concerns over the aging of the Government of Canada's scientific population mounted. In the spring of 1996, the restructured and streamlined DFO Maritimes Region Science Branch became fully operational. It had a new director, a new management structure with eight divisions, a program coordination office and an office for the coordination of the regional scientific advisory process (RAP). Regional staff were integrated and located at BIO, the Gulf Fisheries Centre in Moncton, NB, the St. Andrew's Biological Station in St. Andrews, NB, and the Halifax Fisheries Research Laboratory in Halifax.

Mr. John S. Loch was appointed Regional Science Director.

The Marine Assessment and Liaison Division (MALD) was disbanded upon the retirements of Mr. H. Brian Nicholls and Dr. Gerald Seibert.

Dr. David B. Prior resigned as Director of the Atlantic Geoscience Centre (AGC) and was replaced by Dr. Jacob Verhoef. The Atlantic Geoscience Centre was renamed Geological Survey of Canada, Atlantic (GSCA).

The Project Office of the International Ocean Colour Coordination Group, which reported to the Scientific Committee on Oceanic Research (SCOR), was created at BIO and headed by Dr. Venetia Stuart.

After these major changes, the much reduced staff at BIO was now organized as follows:

Fisheries and Oceans Canada
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Maritime Centre)

Science Branch (J.S. Loch, Regional Director)

- Aquaculture Division (W. Watson-Wright) (St. Andrews Biological Station)
- Diadromous Fish Division (J.A. Ritter) (Maritime Centre)
- Habitat Management Division (G. Sirois) (Gulf Fisheries Centre)
- Hydrography Division (Canadian Hydrographic Service Atlantic) (P. Bellemare)
- Invertebrate Fisheries Division (E.M.P. Chadwick) (Gulf Fisheries Centre)
- Marine Environmental Sciences Division (P.D. Keizer)
- Marine Fish Division (M.M. Sinclair)
- Ocean Sciences Division (J.A. Elliott)

Human Resources Branch (J. Feetham)

Finance and Administration Branch (G.C. Bowdridge) (Maritime Centre)

- Library Services (A.R. Fiander)

Communications Branch (A.M. Lanteigne) (Gulf Fisheries Centre)

Informatics Branch (E. Doucet) (Maritime Centre)

Technical Support Services (M. Cusack) (Queen Square)

- Engineering and Technical Services (D.F. Dinn)
- Vessel Support (G. Putt) (Queen Square)

Aquaculture Coordination Office (R.H. Cook) (Maritime Centre)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)

- Marine Regional Geoscience Division (R. Courtney)
- Marine Resource Geoscience Division (K.D. McAlpine)

- Environmental Marine Geoscience Division (R.A. Pickrill)
- Administration (G. McCormack)

Environment Canada
Canadian Wildlife Service

- Marine Wildlife Conservation Division (E.H.J. Hiscock)
    - Seabird Science (D.N. Nettleship)
    - Bay of Fundy Science (P.G. Wells)

Environmental Protection Service

- Environmental Quality Laboratory (K.G. Doe)
- Shellfish and Microbiology Laboratory (C. Craig)

Department of National Defence

- Route Survey Office (J. Bradford)

Several private companies leased space on the BIO campus.

Others on the BIO campus included:

- International Ocean Colour Coordinating Group (IOCCG) (V. Stuart)

1997

Mr. Paul Bellemare departed to become Director of Policy, Planning and Marketing for the Canadian Hydrographic Service (CHS) in Ottawa and was replaced as Director of CHS by Ms. Laureen Kinney.

The regional Oceans Act Coordination Office (OACO) was established to lead delivery of DFO's responsibilities under the newly proclaimed Oceans Act and Ms. Faith G. Scattolon was appointed as Director.

The Halifax Fisheries Research Laboratory was closed and staff transferred to BIO, St. Andrews or the Gulf Fisheries Centre. Soon after, the buildings were torn down and the site converted to a parking lot (now part of the Queens Marque development).

In Environment Canada, the Environmental Quality Laboratory moved from BIO to the Environmental Science Centre on the University of Moncton campus in Moncton, NB. However, the Environmental Protection Microbiology Laboratory remained at BIO to continue shellfish water quality monitoring throughout the three Maritime Provinces. In addition, the Marine Wildlife Conservation Division of the Canadian Wildlife Service moved to Queen Square in downtown Dartmouth. These moves significantly reduced the presence of Environment Canada on the BIO campus.

The Maritimes Regional Advisory Process (RAP) Office was established to provide peer-reviewed scientific advice to DFO clients on the management and conservation of Canadian marine and freshwater aquatic resources and their habitats. This new office, headed by Mr.

Robert N. O'Boyle, took over the responsibilities of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) that had been disbanded a few years earlier.

1998

Ms. Laureen Kinney, Director of the Canadian Hydrographic Service (CHS) left for a position in the Pacific Region and was replaced by Mr. Charles Stirling. Dr. Thomas W. Sephton took over as Director of the St. Andrews Biological Station and Mr. Brian Thompson became head of the Habitat Management Division.

The Bedford Institute of Oceanography Oceans Association (BIO-OA) was founded as an autonomous private organization to foster communication between current and past BIO staff, organize social events, conduct projects and preserve the history of BIO.

The BIO Gift Shop was opened and carried various items including publications, clothing and novelties.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Maritime Centre)

Science Branch (J.S. Loch, Regional Director)
- Aquaculture Division (T.W. Sephton) (St. Andrews Biological Station)
- Canadian Hydrographic Service, Atlantic (L. Kinney)
- Diadromous Fish Division (J.A. Ritter) (Maritime Centre)
- Habitat Management Division (B.D. Thompson) (Maritime Centre)
- Invertebrate Fisheries Division (E.M.P. Chadwick) (Gulf Fisheries Centre)
- Marine Environmental Sciences Division (P.D. Keizer)
- Marine Fish Division (M.M. Sinclair)
- Ocean Sciences Division (R.A. Clarke)
- Oceans Act Coordination Office (F.G. Scattolon)
- Program Planning and Coordination (R.A. Eisner)
- Regional Advisory Process Office (R.N. O'Boyle)

Finance and Administration Branch (L.M. Thibeau) (Maritime Centre)
- Assets Management Division (M. Chin-Yee)
- Library Services Division (A.R. Fiander)

Communication Branch (A.-M. Lanteigne) (Gulf Fisheries Centre)

Informatics Branch (J.E. Doucet) (Maritime Centre)
- Application Services Division (T.H. Wagg) (Maritime Centre)
- Technology Services Division (D.M. Porteous)

Canadian Coast Guard (L.J. Wilson, Regional Director) (Parker Street Base)

- Marine Programs (J. Calvesbert) (Parker Street Base)
- Operational Services (M. Cusack (Queen Square)
- Technical Support Services (D. Parkes) (Parker Street Base)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)

- Marine Resources Geoscience Division (K.D. McAlpine)
- Marine Environmental Geoscience Division (R.A. Pickrill)
- Marine Regional Geoscience Division (M. Williamson)
- Administration (G. McCormack)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig, A. Menon)

Department of National Defence
Route Survey Office (J. Bradford)
A number of private companies and agencies leased space at BIO to undertake work related to the marine sciences.
Others on the BIO campus included:

- International Ocean Colour Coordinating Group (IOCCG) (V. Stuart)

1999

The Gulf Region was re-established in DFO, thereby reversing the earlier decision in 1995 to merge it with the Scotia-Fundy Region. This action produced another major reorganization of research and resource management programs at BIO, the St. Andrews Biological Station and the Gulf Fisheries Centre. The scientific staff at the Gulf Fisheries Centre now reported to a new science director in the Gulf Region. Dr. Michael M. Sinclair became the new Science Director for the Maritimes Region and Mr. Richard MacDougall became head of the Canadian Hydrographic Service (Atlantic). The Oceans Act Coordination Office evolved into the Oceans and Environment Branch and Ms. Faith G. Scattolon continued as director. This new organization included the Environmental Sciences Division that had previously been under the Science Branch.

The Diadromous Fish and Habitat Management Divisions moved from the Maritime Centre to BIO. A Maritimes Aquatic Species at Risk Office was established and Mr. John S. Loch was appointed Manager.

The Centre for Marine Biodiversity was established as a non-profit society with membership from several Department of Fisheries and Oceans laboratories, Dalhousie University and the Atlantic Reference Centre of the Huntsman Marine Science Centre in St. Andrews, NB. The purpose of the Centre was to embrace scientific capacity in support and protection of marine biodiversity with a focus on the Northwest Atlantic. Dr. Ellen L.R. Kenchington was appointed as the Executive Director.

2000

The DFO Regional Headquarters moved from the Maritime Centre in Halifax to Marine House in downtown Dartmouth.

In the Science Branch, Mr. Larry Marshall became head of the Diadromous Fish Division, Dr. Réne Lavoie became head of the Invertebrate Fisheries Division and Dr. Wayne Stobo became head of the Marine Fish Division. Mr. Carl Myers took over as head of Communications.

The remaining engineering expertise in DFO was consolidated into the Ocean Physics Section headed by Dr. Alex Herman.

The Oceans and Coastal Management Division was created in the Oceans and Environment Branch and headed by Mr. Joe Arbour.

The DFO Aquaculture Coordination Office moved from the Maritime Centre to BIO and was now headed by Mr. Michael Murphy.

Canadian Coast Guard Technical Services moved from the Parker Street base to BIO.

The SeaMap Office was established at BIO under the support of the Department of Fisheries and Oceans, Natural Resources Canada and the Department of National Defence. Dr. Kate Moran was appointed Project Manager. This office developed a proposal for a national program to create a habitat map for Canada's entire seabed that was not funded.

The office for the Partnership for Ocean Global Observations (POGO) was established at BIO to provide support for deep-ocean research and monitoring activities on a global scale. Dr. Shubha Sathyendranath was appointed as Executive Director.

BIO was now organized as follows:

Fisheries and Oceans Canada
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Marine House)

Science Branch (M.M. Sinclair, Director)

- Aquaculture Division (T.W. Sephton) (St. Andrews Biological Station)
- Canadian Hydrographic Service (R. MacDougall)
- Diadromous Fish Division (L. Marshall)
- Invertebrate Fisheries Division (R. Lavoie)
- Marine Fish Division (W. Stobo)
- Ocean Sciences Division (R.A. Clarke)
    - Biological Oceanography (T.C. Platt)
    - Coastal Ocean Science (P.C. Smith)
    - Ocean Circulation (M. Mitchell)
    - Ocean Physics (A. Herman)

- Technical Operations (D.L. McKeown)

- Maritimes Regional Advisory Process (RAP) (R.N. O'Boyle)
- Maritimes Aquatic Species at Risk Office (J.S. Loch)

Oceans and Environment Branch (F. G. Scattolon, Director)
- Habitat Management Division (B. Thompson)
- Marine Environmental Sciences Division (P.D. Keizer)
- Oceans and Coastal Management Division (J. Arbour)

Aquaculture Coordination Office (M. Murphy)

Finance and Administration
- Library (A.R. Fiander)
- Procurement
- Stores
- Material Services

Communications Branch (C. Myers)

Informatics
- Technology Services (S. Gallagher)
- Records (J. Martell)
- Applications (J. O'Neill)

Canadian Coast Guard – Technical Services
- Mechanical and Oceanographic Systems Development (G. Steeves)
- Technical Maintenance (J. Wilson)
- Vessel Support (A. Muise)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Administration
- Marine Resources Geoscience Division (D. McAlpine)
- Marine Environmental Geoscience Division (R.A. Pickrill)
- Marine Regional Geoscience Division (M. Williamson)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Service (B. FitzPatrick)

Health Canada (M. Brackett)

National Research Council Canada (D. Douglas)

Others on the BIO campus included:
- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- SeaMap Office (K. Moran)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2001

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Marine House)

Science Branch (M.M. Sinclair, Director)
- Aquaculture Division (T.W. Sephton) (St. Andrews Biological Station)
- Canadian Hydrographic Service (Atlantic) (R. MacDougall)
- Diadromous Fish Division (L. Marshall)
- Invertebrate Fisheries Division (R. Lavoie)
- Marine Fish Division (W. Stobo)
- Ocean Sciences Division (A. Clarke)
    - Biological Oceanography (W.G. Harrison)
    - Coastal Ocean Science (P.C. Smith)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (M. Mitchell)
    - Technical Operations (D.L. McKeown)
- Maritimes Regional Advisory Process (RAP) (R.N. O'Boyle)
- Maritimes Aquatic Species at Risk Office (J.S. Loch)

Oceans and Environment Branch (F.G. Scattolon, Director)
- Habitat Management Division (B. Thompson)
- Marine Environmental Sciences Division (P.D. Keizer)
- Oceans and Coastal Management Division (J. Arbour)

Aquaculture Coordination Office (M. Murphy)

Finance and Administration
- Library (A.R. Fiander)
- Procurement (J. Hebert-Sellars)
- Stores

Communications Branch (C. Myers)

Informatics
- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Records (J. Martell)
- Applications (T. Spears)

Canadian Coast Guard – Technical Services
- Mechanical and Oceanographic Systems Development (G. Steeves)
- Technical Maintenance (J. Wilson)
- Vessel Support (A. Muise)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Administration (G. McCormack)
- Marine Resources Geoscience Division (D. McAlpine)
- Marine Environmental Geoscience Division (R.A. Pickrill)
- Marine Regional Geoscience Division (M. Williamson)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Service (L. Lohnes)

Health Canada (H. Skinner)

National Research Council Canada (D. Douglas)

Others on campus included:
- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- SeaMap Office (G. Rockwell)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2002

BIO celebrated its 40th anniversary and hosted a two-day symposium on the *Future Challenges of Marine Sciences in Canada*. In addition, Symphony Nova Scotia performed an anniversary concert in the auditorium. The annual report was dedicated to Dr. William van Steenburgh, Dr. William Cameron, Dr. William English and Dr. William L. Ford, the four Bills who were instrumental in founding and bringing BIO to the forefront as a world-class oceanographic institute.

The DFO National Centre for Offshore Oil and Gas Environmental Research (COOGER) was established to facilitate the development of marine environmental and oceanographic research programs related to oil and gas activities. Dr. Ken Lee was appointed Executive Director. The Centre provided a focus for research activities on offshore oil and gas in DFO as well as a single point of contact for external agencies and industry.

Dr. Peter C. Smith took over as head of the Ocean Sciences Division. The Marine Environmental Sciences Division moved from the Oceans and Environment Branch back into the Science Branch. Mr. Paul D. Boudreau became head of the Habitat Management Division and Mr. Mark Cusack took over as head of the Aquaculture Coordination Office.

The Hypatia Project was launched under the lead of Dr. Sherry Nevin to identify and develop a strategy to reduce the factors limiting the recruitment, participation and retention of women in science and technology positions.

Natural Resources Canada established the office of the Climate Change Impacts and Adaptation Research Network Coastal Node at BIO to support coastal research in Atlantic Canada that contributed to Canada's climate change program.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Marine House)

Science Branch (M.M. Sinclair, Director)

- Aquaculture Division (T.W. Sephton) (St. Andrews Biological Station)
- Canadian Hydrographic Service (Atlantic) (R. MacDougall)
- Diadromous Fish Division (L. Marshall)
- Invertebrate Fisheries Division (R. Lavoie)
- Maritimes Aquatic Species at Risk Office (E.L.R. Kenchington)
- Marine Fish Division (W. Stobo)
- Ocean Sciences Division (P.C. Smith)
    - Biological Oceanography (W.G. Harrison)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (M. Mitchell)

    - Technical Operations (D.L. McKeown)
- Marine Environmental Sciences Division (P.D. Keizer)
- Maritimes Provinces Regional Advisory Process (RAP/Outreach) (R.N. O'Boyle)

Oceans and Environment Branch (F.G. Scattolon, Director)
- Habitat Management Division (P.D. Boudreau)
- Oceans and Coastal Management Division (J. Arbour)

Aquaculture Coordination Office (M. Cusack)

Hypatia Project (S. Niven)

Finance and Administration
- Procurement (J. Hebert-Sellars)
- Material Services (Stores)

Communications Branch (C. Myers)

Informatics
- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Applications (T. Spears)
- Library (A.R. Fiander)
- Records (J. Martell)

Canadian Coast Guard – Technical Services
- Systems Engineering Group (G. Steeves)
- Technical Maintenance (J. Wilson)
- Vessel Support (A. Muise)
- Dartmouth Technical Workshop (P. Mckiel)

Canadian Coast Guard – Central and Arctic, Operational Services (M. Brackett)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Administration (G. McCormack)
- Marine Resources Geoscience Division (M. Williamson)
- Marine Environmental Geoscience Division (R.A. Pickrill)

Department of National Defence
Route Survey Office (R. Smith)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Health Canada (H. Skinner)

National Research Council Canada (D. Douglas)

Others on campus included:
- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Centre for Marine Biodiversity
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2003

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Marine House)

Science Branch (M.M. Sinclair, Director)
- Aquaculture Division (T.W. Sephton) (St. Andrews Biological Station)
- Canadian Hydrographic Service (Atlantic) (R. MacDougall)
- Diadromous Fish Division (L. Marshall)
- Invertebrate Fisheries Division (R. Lavoie)
- Marine Fish Division (W. Stobo)
- Ocean Sciences Division (P.C. Smith)
    - Biological Oceanography (W.G. Harrison)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (M. Mitchell)
- Marine Environmental Sciences Division (P.D. Keizer)
- Maritimes Provinces Regional Advisory Process (RAP/Outreach) (R.N. O'Boyle)
- Maritimes Species at Risk Coordination Office (J. Conway)

Oceans and Environment Branch (F.G. Scattolon, Director)
- Habitat Management Division (P.D. Boudreau)
- Oceans and Coastal Management Division (J. Arbour)

Aquaculture Coordination Office (M. Cusack)

Hypatia Project (S. Niven)

Finance and Administration

- Contract Services (J. Hebert-Sellars)
- Material Services (Stores)

Communications Branch (C. Myers)

Informatics

- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Application Services (J. Gale)
- Special Projects (J. O'Neill)
- Library (A.R. Fiander)
- Records (J. Martell)

Canadian Coast Guard – Technical Services

- Systems Engineering Group (G. Steeves)
- Marine Electronics (J. Wilson)
- Vessel Support (A. Muise)
- Marine Aids and Maintenance (P. Nelson)
- Dartmouth Technical Workshop (P. Mckiel)

Canadian Coast Guard – Operational Services (M. Brackett)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)

- Administration (G. McCormack)
- Marine Resources Geoscience Division (M. Williamson)
- Marine Environmental Geoscience Division (R.A. Pickrill)

Department of National Defence
Route Survey Office (R. Smith)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

National Research Council of Canada (D. Douglas)

Others on campus include:

- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2004

The Oceans and Environment Branch became the Oceans and Habitat Branch.

The Systems Engineering Group moved from the Coast Guard back to the Science Branch and was incorporated into the Ocean Sciences Division.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Marine House)

Science Branch (M.M. Sinclair, Director)
- Program Planning and Coordination (J. O'Neill)
- Aquaculture Division (T.W. Sephton) (St. Andrews Biological Station)
- Canadian Hydrographic Service (Atlantic) (R. MacDougall)
- Diadromous Fish Division (L. Marshall)
- Invertebrate Fisheries Division (R. Lavoie)
- Marine Fish Division (W. Stobo)
- Ocean Sciences Division (P.C. Smith)
    - Biological Oceanography (W.G. Harrison)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (M. Mitchell)
    - Systems Engineering (G. Steeves)
- Marine Environmental Sciences Division (P.D. Keizer)
- Maritimes Provinces Regional Advisory Process (RAP/Outreach) (R.N. O'Boyle)
- Maritimes Species at Risk Office Coordination Office (A. McPherson)

Oceans and Habitat Branch (F.G. Scattolon, Director)
- Habitat Management Division (P.D. Boudreau)
- Oceans and Coastal Management Division (J. Arbour)

Aquaculture Coordination Office (M. Cusack)

Real Property Safety and Security Branch (B. Thompson)

Finance and Administration
- Contract Services (J. Hebert-Sellars)
- Material Services (Stores)

Communications Branch (C. Myers)

Informatics

- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Program Services (T. Spears)
- Library (A.R. Fiander)
- Records (J. Martell)

Canadian Coast Guard – Technical Services
- Marine Electronics (J. Wilson)
- Vessel Support (A. Muise)
- Marine Aids and Maintenance (P. Nelson)
- Dartmouth Technical Workshop (P. Mckiel)

Canadian Coast Guard – Operational Services (M. Brackett)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Administration (G. McCormack)
- Marine Resources Geoscience Division (D. McAlpine)
- Marine Environmental Geoscience Division (G. Sonnichsen)

Department of National Defence

Route Survey Office (J. Bradford)

Environment Canada

Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Others on campus included:
- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2005

There were major changes in the organization of the DFO Science Branch brought about by declining staff and the need to consolidate. The Diadromous Fish, Invertebrate Fisheries and Marine Fish Divisions were merged and became the Population Ecology Division headed by Dr. Ross R. Claytor. The Marine Environmental Sciences Division and the Biological Oceanography Section were merged to create the Ecosystem Research Division headed by Dr.

Thomas W. Sephton. Dr. Robert L. Stephenson became Director of the St. Andrews Biological Stations and all resident program managers reported directly to him.

The Environmental Assessment and Major Projects Division was created in the Oceans and Habitat Branch and headed by Mr. Ted Potter.

The United Nations Convention on the Law of the Sea (UNCLOS) Program Office was established to oversee and coordinate the UNCLOS mapping effort being undertaken jointly by the Geological Survey of Canada (Atlantic) and the Canadian Hydrographic Service at BIO.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (N.A. Bellefontaine) (Marine House)

Science Branch (M.M. Sinclair, Director)
- Innovation Office (R. Eisner)
- St. Andrews Biological Station (R.L. Stephenson)
- Canadian Hydrographic Service (Atlantic) (R. MacDougall)
- Population Ecology Division (R.R. Claytor)
- Ocean Sciences Division (P.C. Smith)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (M. Mitchell)
- Science Informatics (J. O'Neill)
- Ecosystem Research Division (T.W. Sephton)
    - Marine Chemistry (P.A. Yeats)
    - Centre for Offshore Oil and Gas Environmental Research (K. Lee)
    - Habitat Ecology (T.G. Milligan)
    - Biological Oceanography (W.G. Harrison)
- Maritimes Regional Advisory Process (RAP) (R.N. O'Boyle)
- Maritimes Species at Risk Coordination Office (A. McPherson)

Oceans and Habitat Branch (F.G. Scattolon, Director)
- Environmental Assessment and Major Projects Division (T. Potter)
- Habitat Management Division (P.D. Boudreau)
- Oceans and Coastal Management Division (J. Arbour)

Aquaculture Management (M. Cusack)

Finance and Administration
- Contract Services (J. Hebert-Sellars)
- Material Services (Stores)

Real Property Safety and Security Branch (B. Thompson)

Communications Branch (C. Myers)

Corporate Services (V. Bradshaw)

Planning and Information Services
- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Library (A.R. Fiander)
- Records (J. Martell)

Canadian Coast Guard – Technical Services
- Marine Electronics (J. Wilson)
- Vessel Support (A. Muise)
- Marine Aids and Maintenance
- Dartmouth Technical Workshop (P. Mckiel)

Canadian Coast Guard – Operational Services (M. Brackett)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Shared Services Office (G. McCormack)
- Marine Resources Geoscience Division (D. McAlpine)
- Marine Environmental Geoscience Division (G. Sonnichsen)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Others on campus included:
- International Ocean Colour Coordinating Group (IOCCG) (V. Stuart)
- Partnership for Observation of the Global Oceans (POGO) (S. Sathyendranath)
- Fishermen and Scientists Research Society (FSRS)
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2006

Mr. Neil A. Bellefontaine retired as Regional Director-General and was replaced by Ms. Faith G. Scattolon. Ms. Carol Anne Rose became Director of the Oceans and Habitat Branch.

The Regional Advisory Process office evolved into the Centre of Science Advice and was still headed by Mr. Robert N. O'Boyle.

The Program Planning and Coordination Division was created in the Oceans and Habitat Branch and headed by Mr. Tim Hall.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (F.G. Scattolon) (Marine House)

Science Branch (M.M. Sinclair, Director)
- St. Andrews Biological Station (R.L. Stephenson)
- Canadian Hydrographic Service (Atlantic) (R. MacDougall)
- Ecosystem Research Division (T.W. Sephton)
    - Marine Chemistry (P.A. Yeats)
    - Centre for Offshore Oil and Gas Environmental Research (K. Lee)
    - Habitat Ecology (T.G. Milligan)
    - Biological Oceanography (W.G. Harrison)
- Ocean Sciences Division (P.C. Smith)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (M. Mitchell)
- Science Informatics (J. O'Neill)
- Population Ecology Division (R.R. Claytor)
- Centre for Science Advice, Maritimes Region and Gulf Region (R.N. O'Boyle)

Oceans and Habitat Branch (C.A. Rose, Director)
- Environmental Assessment and Major Projects Division (T. Potter)
- Habitat Management Division (P.R. Boudreau)
- Oceans and Coastal Management Division (J. Arbour)
- Program Planning and Coordination Division (T. Hall)

Aquaculture Management (M. Cusack)

Finance and Administration
- Contract Services (J. Hebert-Sellars)
- Material Services (Stores)

Real Property Safety and Security Branch (B. Thompson)

Communications Branch (C. Myers)

Corporate Services (V. Bradshaw)

Species at Risk Coordination Office (A. McPherson)

Planning and Information Services
- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Library (A.R. Fiander)
- Records (J. Martell)

Canadian Coast Guard – Technical Services
- Marine Electronics (J. Wilson)
- Vessel Support (A. Muise)
- Marine and Civil Infrastructure
- Dartmouth Technical Workshop (P. Mckiel)

Canadian Coast Guard – Operational Services (M. Brackett)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Shared Services Office (G. McCormack)
- Marine Resources Geoscience Division (S.A. Dehler)
- Marine Environmental Geoscience Division (G. Sonnichsen)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Others on campus include:
- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2007

Mr. Richard MacDougall became the Director of the Law of the Sea Project, the DFO lead in the United Nations Convention on the Law of the Sea (UNCLOS) Office, and Mr. Stephen R. Forbes became the new Director of the Canadian Hydrographic Service (Atlantic). Mr. Michel Mitchell took over as manager of the Ocean Sciences Division and Mr. Michael Murphy became the new director of the Oceans and Habitat Branch.

The Marine Chemistry Section in the Ecosystem Research Division (ERD) was discontinued and the remaining work on marine contaminants and chemical oceanography was incorporated into other ERD sections. This marked the end of a formal marine chemistry group at BIO.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (F.G. Scattolon) (Marine House)

Science Branch (M.M. Sinclair, Director)
- St. Andrews Biological Station (R.L. Stephenson)
- Canadian Hydrographic Service (Atlantic) (S.R. Forbes)
- UNCLOS Program Office (R. MacDougall)
- Ecosystem Research Division (T.W. Sephton)
    - Centre for Offshore Oil and Gas Environmental Research (K. Lee)
    - Habitat Ecology (T.G. Milligan)
    - Ocean Research and Monitoring (W.G. Harrison)
- Ocean Sciences Division (M. Mitchell)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (T.G. Milligan)
- Ocean Data and Information Services (J. O'Neill)
- Population Ecology Division (R.R. Claytor)
- Centre for Science Advice, Maritimes Development Division (P.R. Boudreau)
- Oceans and Coastal Management Division (J. Arbour)
- Program Planning and Coordination Division (T. Hall)

Aquaculture Management (M. Cusack)

Finance and Administration
- Contract Services (J. Hebert-Sellars)
- Material Services (Stores) (L. MacDonald)

Real Property Safety and Security Branch (B. Thompson)

Communications Branch (C. Myers)

Species at Risk Coordination Office (A. McPherson)

Information Management and Technology Services (S. Graham)
- Planning and Information Management Services (D. Earle)
- Technology Services (G. Somerton)
- Client Services (S. Gallagher)
- Library (A.R. Fiander)

- Records (J. Martell)

Canadian Coast Guard – Technical Services
- Marine Electronics (J. Wilson)
- Vessel Support (A. Muise)
- Marine and Civil Infrastructure
- Dartmouth Technical Workshop (P. Mckiel)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (J. Verhoef, Director)
- Shared Services Office (G. McCormack)
- Marine Resources Geoscience Division (S.A. Dehler)
- Marine Environmental Geoscience Division (G. Sonnichsen)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Others on campus include:
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- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2008

This year marked the 100th anniversary of the St. Andrews Biological Station and a special symposium on its history was held to celebrate the event. A commemorative volume was later published (Hubbard et. al. 2016).

Dr. Alain Vézina took over as manager of the Ecosystem Research Division while Dr. Thomas W. Sephton became head of the new Strategic Planning, Advisory Activities and Outreach Division.

The Oceans and Habitat Branch became the Oceans, Habitat and Species at Risk Branch and the Habitat Protection and Sustainable Development Division was created under the head of Mr. M. Cherry.

Dr. Jacob Verhoef became director of UNCLOS as the NRCan lead in the United Nations Convention on the Law of the Sea (UNCLOS) Program Office.

Mr. Stephen Locke became the new director of Geological Survey of Canada (Atlantic).

BIO was now organized as follows:

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Science Branch (M.M. Sinclair, Director)
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- Canadian Hydrographic Service (Atlantic) (S.R. Forbes)
- UNCLOS Program Office (R. MacDougall)
- Ecosystem Research Division (A. Vézina)
    - Centre for Offshore Oil and Gas Environmental Research (K. Lee)
    - Habitat Ecology (E.J. Kennedy)
    - Ocean Research and Monitoring (W.G. Harrison)
- Ocean Sciences Division (M. Mitchell)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (T.G. Milligan)
- Ocean Data and Information Services (J. O'Neill)
- Population Ecology Division (R.R. Claytor)
- Strategic Planning, Advisory Activities and Outreach Division (T.W. Sephton)

Oceans, Habitat and Species at Risk Branch (M. Murphy, Director)
- Environmental Assessment and Major Projects Division (T. Potter)
- Habitat Protection and Sustainable Development Division (M. Cherry)
- Oceans and Coastal Management Division (T. Hall)
- Program Planning and Coordination (O.C. Murphy)
- Species at Risk Coordination Office (D. Millar)

Fisheries and Aquaculture Management
- Aquaculture Management Office (C. Webster)

Finance and Administration
- Material Services (Stores) (L. MacDonald)
- Real Property Safety and Security Branch (B. Thompson)

Communications Branch (C. Myers)

Information Management and Technology Services (S. Graham)
- Infrastructure and Operation (Data Centre) (G. Somerton)
- Networks
- Service Desk
- Telephony

- Library (A.R. Fiander)
- Records (J. Martell)

Canadian Coast Guard – Technical Services
- Marine Electronics (J. Wilson)
- Vessel Support (D. Chipman)
- Marine and Civil Infrastructure
- Dartmouth Technical Workshop (P. Mckiel)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (S. Locke, Director)
- Shared Services Office (G. McCormack)
- Marine Resources Geoscience Division (S. Dehler)
- Marine Environmental Geoscience Division (G. Sonnichsen)
- UNCLOS Program Office (J. Verhoef)
- ESS Office (A. Sherin)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Others on campus included:
- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2009

Mr. Richard MacDougall retired as Director, Law of the Sea Project (UNCLOS Program Office) and was replaced by Mr. Julian Goodyear.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (F.G. Scattolon) (Marine House)

Science Branch (M.M. Sinclair, Director)
- St. Andrews Biological Station (R.L. Stephenson)

- Canadian Hydrographic Service (Atlantic) (S.R. Forbes)
- UNCLOS Program Office (R. MacDougall/Julian Goodyear)
- Ecosystem Research Division (A. Vézina)
    - Centre for Offshore Oil and Gas Environmental Research (K. Lee)
    - Habitat Ecology (E.J. Kennedy)
    - Ocean Research and Monitoring (W.G. Harrison)
- Ocean Sciences Division (M. Mitchell)
    - Coastal Ocean Science (S.J. Prinsenberg)
    - Ocean Circulation (J.W. Loder)
    - Ocean Physics (T.G. Milligan)
- Ocean Data and Information Services (J. O'Neill)
- Population Ecology Division (R.R. Claytor)
- Strategic Planning, Advisory Activities and Outreach Division (T.W. Sephton)

Oceans, Habitat and Species at Risk Branch (M. Murphy, Director)
- Environmental Assessment and Major Projects Division (T. Potter)
- Habitat Protection and Sustainable Development Division (M. Cherry)
- Oceans and Coastal Management Division (T. Hall)
- Program Planning and Coordination (O.C. Murphy)
- Species at Risk Management (D. Millar)

Finance and Administration
- Material Services (Stores) (L. MacDonald)
- Real Property Safety and Security Branch (H. Cararisti)

Communications Branch (C. Myers)

Information Management and Technology Services
- Planning and Architecture Enterprise (S. Graham)
- Infrastructure and Operation (Data Centre) (G. Somerton)
- Data Centre
- Networks and Telephone
- Security
- Service Desk
- Library (A.R. Fiander)
- Records (T. Rioux)

Canadian Coast Guard – Technical Services
- Marine Electronics (R. MacGregor)
- Marine Engineering (D. Chipman)
- Dartmouth Technical Workshop (P. Mckiel)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (S. Locke, Director)

- Shared Services Office (G. McCormack)
- Marine Resources Geoscience Division (S.A. Dehler)
- Marine Environmental Geoscience Division (G. Sonnichsen)
- UNCLOS Program Office (J. Verhoef)
- Mapping Information Office (K. Jarrett)
- Programs and Operations (A. Sherin)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

Others on campus include:

- International Ocean Colour Coordinating Group (V. Stuart)
- Partnership for Observation of the Global Oceans (S. Sathyendranath)
- Fishermen and Scientists Research Society
- Geoforce Consultants Ltd.
- Numerous contractors and emeritus scientists

2010

Dr. Michael M. Sinclair retired as Director of the DFO Science Branch and was replaced by Dr. Alain Vézina.

The Tuesday Club was renamed the BIO Campus Management Committee. It continued as before to be responsible for the management of all activities and processes common to all scientific, operational and policy organizations on the BIO campus.

A new Science Management Committee was established with membership from the four science departments on the BIO campus (DFO, NRCan, EC and DND). The mandate of this committee was identify gaps in scientific programs and take steps to correct them.

The Oceans, Habitat and Species at Risk Branch was renamed the Ecosystem Management Branch and Mr. David Millar took over as director.

2011

Mr. Julian Goodyear retired as the DFO Director of the UNCLOS Program Office and was replaced by Mr. Stephen R. Forbes. Mr. Michel Goguen replaced Mr. Stephen Forbes as the director of the Canadian Hydrographic Service (CHS) Atlantic.

2012

BIO celebrated its 50th anniversary on 25 October with an open house, climate change workshop, a 'Gala Celebration' and presentation of Crystal Awards to outstanding BIO team projects over five decades. In addition, the preparation of a commemorative book entitled *Voyage of Discovery, Fifty Years of Marine Research at Canada's Bedford Institute of Oceanography*, was well underway and subsequently published by the BIO-OA in 2014.

BIO was now organized as follows:

Department of Fisheries and Oceans
Maritimes Region
Regional Director-General (F.G. Scattolon) (Marine House)

Science Branch (A.F. Vézina, Director)

- Canadian Hydrographic Service (Atlantic) (M.C. Goguen)
    - Production and Tidal Section (J. Cormier)
    - Marine Geomatics Support Section (T. Roswell)
- UNCLOS Program Office (S.R. Forbes)
- Coastal Ecosystem Science Division and St. Andrews Biological Station (S.E. McGladdery)
    - Habitat Ecology Section (E.J. Kennedy)
    - Coastal Oceanography and Ecosystem Research Section (F.H. Page)
    - Biological Effects Section (L. Cooper)
- Ocean and Ecosystem Sciences Division (C.G. Hannah)
    - Centre for Offshore Oil and Gas Environmental Research (K. Lee)
    - Marine Ecosystem Section (W.K.W. Li)
    - Oceanography and Climate Section (B.J.W. Greenan)
- Population Ecology Division (R.R. Claytor)
    - Administration Management Section (J.I. McMillan)
    - Eastern Scotian Shelf Section (R.R. Claytor)
    - Gulf of Maine Section (K.J. Clark)
    - Inshore Western Section (S.F. O'Neil)
    - Western Scotian Shelf Section (P.C. Hurley)
- Program Coordination and Support Division (T.W. Sephton)
    - Aquatic Biotechnology Laboratory (L.C. Hamilton)
    - Ocean Data and Information Section (T.W. Spears)
    - Ocean Physics Section (J.T. O'Neill)
- Centre for Science Advice, Maritimes (T. Worcester)

Ecosystem Management Branch (D. Millar, Director)

- Environmental Assessment and Major Projects Division (D. Humphrey)
- Habitat Protection and Sustainable Development Division (K. Smedbolt)
- Oceans and Coastal Management Division (T. Hall)
- Species at Risk Management (M. Penny-Ferguson)

Finance and Administration

- Material Services (Stores) (L. MacDonald)
- Real Property Safety and Security Branch (H. Caracristi)

Communications Branch (C. Myers)

Information Management and Technology Services

- Planning and Architecture Enterprise (S. Graham)
- Infrastructure and Operation (Data Centre) (G. Somerton)
- Library (A. Fiander)

Canadian Coast Guard – Technical Services

- Marine Electronics (R. MacGregor)
- Marine Engineering (D. Chapman)
- Dartmouth Technical Workshop (P. McKiel)

Natural Resources Canada
Geological Survey of Canada (Atlantic) (S. Locke, Director)

- Marine Resources Geoscience Division (S.A. Dehler)
- Marine Environmental Geoscience Division (G. Sonnichsen)
- UNCLOS Program Office (J. Verhoef)

Department of National Defence
Route Survey Office (J. Bradford)

Environment Canada
Canadian Shellfish Sanitation Program (C. Craig)

Public Works and Government Services (L. Lohnes)

FACILITIES

This section documents the evolution of facilities on the BIO campus, including new buildings, renovations, wharfs and special features.

1962

The facilities at the time of opening were the recently constructed Main Building (now Polaris and Van Steenburgh Buildings with additions), the Depot (now Vulcan Building) and the jetty. The entire property was fenced and there was a security guardhouse beside the entrance road at the top of the hill. The lobby of the original main entrance is now on the third floor of Polaris just outside the Huntsman Boardroom with the mosaic of the North Atlantic Ocean still on the floor. Machine shop facilities in the Depot dealt with heavy work associated with the research vessel fleet while machine shop facilities in the Main Building were devoted to instrument development.

1963

There were no major changes in facilities during the year.

1964

Again, there were no major changes in facilities during the year. However, with the steady increase in staff, space was becoming an issue.

1965

The importance of an excellent library at BIO was well recognized and the Library collection, funded jointly by the Marine Sciences Branch and the Fisheries Research Board of Canada, continued to develop. The Library was also used by Dalhousie students and faculty.

A CDC 3100 mainframe computer was installed that increased the capacity for data processing and analysis. A PDP-5 computer was rented for use at sea.

1966

The designed capacity of the original buildings was reached and plans called for continued growth of BIO scientific programs. A joint Marine Sciences Branch and Fisheries Research Board of Canada study documented the need for major additions and a four-year building plan costing $2.3 million was approved to provide a doubling of laboratory and office space, an expanded depot building and the provision of small boat berthing facilities.
Two PDP-8 mini-computers were acquired.

1968

A Fish Laboratory, with continuous flow of temperature-controlled salt and freshwater, was constructed along the shore north of the Depot. Just beyond it, construction started on a temporary trailer complex for housing Marine Ecology Laboratory (MEL) staff to help relieve overcrowding in the Main Building.

A MEL field station was established at Boutilier's Point in St. Margaret's Bay that included a jetty for berthing small vessels. MEL took over responsibility for managing the Ellerslie field station on Prince Edward Island.

The extension of the main laboratory wing (Van Steenburgh) was underway and planning for the expansion of the administrative wing (Polaris) began. The Library was completely refurbished.

The jetty was extended southward to provide sheltered berthing for launches and small research vessels.

The main computer continued to be a CDC 3100 with 16 kilobytes of memory, two disk drives, three tape drives, one paper tape station, one line printer, one card reader and one typewriter. The Institute also possessed four PDP-8 mini-computers; two were used for hardware and software development and two were on the ships.

1969

A fire, caused by a gas explosion, damaged one of the trailers behind the Fish Lab.

1970

Ten new trailers were added to the trailer complex and the Fish Laboratory was doubled to accommodate new Marine Ecology Laboratory and Resource Development Branch pollution staff. The Depot was expanded to provide more space for storage and workshops. The extension to the laboratory wing of the Main Building (Van Steenburgh) was completed and included two unique floor pads constructed for gravimeter research and calibration. One was a floating pad, completely isolated from the building, and the other was connected directly to bedrock. In addition, two new floors were added to the administrative wing (Polaris), including a new 100-seat seminar hall on the top floor that became known as the 6th Floor Seminar Room. For many years, it was the major meeting room at BIO and hosted many events. Additional parking space was added.

A sewage treatment plant was installed at the south end of the campus to reduce solids and biological oxygen demand in effluent discharged into Bedford Basin.

The Argo Building was constructed to provide a regional depository for the mandatory core samples required from all the wells drilled by the oil and gas industry. This function was managed by the Department of Energy, Mines and Resources. This building was named after *Argo*, the ship in Greek mythology on which Jason and the Argonauts sailed to retrieve the Golden Fleece.

The A. Murray MacKay Bridge, overlooking BIO, was completed.

1972

Further improvements were made in the Fish Laboratory and at the MEL field stations in Ellerslie, PEI and St. Margaret's Bay.

The main frame computer was still the CDC 3100 and time-sharing on other regional computers was introduced. Additional mini-computers were obtained for the ships.

1974

Overcrowding of facilities continued and temporary arrangements in the trailers and Depot had to be installed. The design process began for new facilities to provide the needed permanent additions and modernize the existing laboratories. Construction was expected to begin in 1975.

A curation facility was established for geological samples.

A portrait of Dr. William E. van Steenburgh, painted by noted Nova Scotian portrait artist Leon Zwerling, was unveiled by his wife Lydia and their family just a few days before Dr. van Steenburgh died. This painting now hangs in the 4th Floor hallway of the Van Steenburgh Building.

Additional mini-computers were purchased bringing the total to 24 but there was not yet any motivation to link them to form a network. There was continued growth in using external computing facilities, including the CDC Cyber 70 computer owned by the Atmospheric Environment Service in Dorval, QC.

1975

The Honourable Romeo LeBlanc, Minister of State for Fisheries, announced the expenditure of $18 million for an update of the Institute's buildings. The work would be carried out over a period of four years and double the existing space. Three new buildings were planned which included laboratories, offices, meeting rooms, a library, an auditorium, a cafeteria, a computing centre and geological core storage facilities. In addition, a new access road and improvements to the Fish Laboratory were planned.

1976

Construction of the laboratory building between the Depot and Fish Laboratory (later named Strickland Building) was nearing completion while construction began on the laboratory building uphill from the Main Building (later named the Murray Building), which included a new core storage facility.

The upper access road (later named Hudson Way) and upper parking lots were constructed.

The Library made on-line searching of over a dozen scientific databases accessible to BIO scientists. The Library was designated as the major Canadian oceanographic library and a librarian hired to direct the development of a national collection.

Ship-borne computers were modified so that all three major ships had essentially identical and considerably upgraded systems.

A field station was established at Crystal Cliffs on St. George's Bay in a building leased from St. Francis Xavier University.

1978

The $18 million BIO expansion project, announced in May 1975, proceeded on schedule and within cost estimates. The two laboratory buildings were completed and occupied. The new building linking the Depot and Fish Laboratory was named after Dr. John Strickland. He was an outstanding ecologist who began his career with the Fisheries Research Board of Canada in Nanaimo, BC and later moved to the Scripps Institution of Oceanography in La Jolla, CA. This building was occupied by Marine Ecology Laboratory and Environmental Protection Service staff, many of whom had been housed in the trailer complex. The other new building, which contained the new core storage facility, was named after Sir John Murray who was a pioneering Scottish oceanographer, marine biologist and limnologist and considered the father of modern oceanography. This building was occupied by geologists.

Construction began on the new common services building that would contain the new auditorium, library, cafeteria and computer centre. Now that the pressure on space had been reduced, the phasing out of the trailer complex began.

C. Anthony Law, an accomplished Halifax artist, participated in an arctic cruise on CSS *Hudson* and subsequently created a painting of the ship along the coast of Baffin Island. This painting was donated to BIO and now hangs just inside the main entrance. It also graces the cover of *Voyage of Discovery*.

1979

An arsonist set a fire that destroyed much of the trailer complex that still housed approximately 75 staff. No one was hurt but much equipment and information was lost.

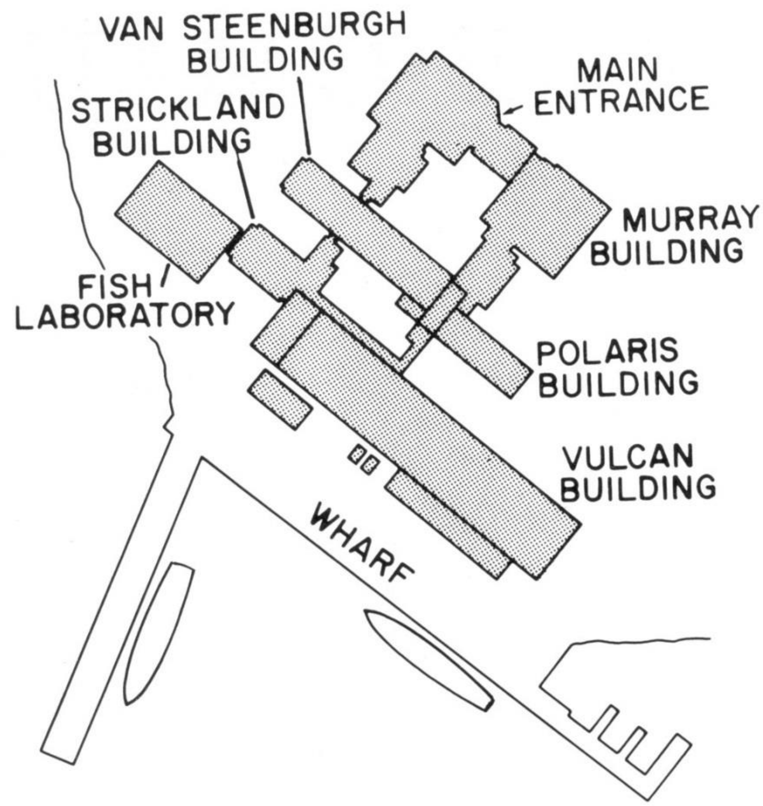
The long-awaited and more versatile CDC Cyber 171 mainframe computer arrived and was installed.

1980

Construction of the common services building was completed and the new auditorium, library, cafeteria and computer centre were occupied. This building was named after Samuel Holland, an engineer who was born in Holland but later came to the new world. He worked with Capt. James Cook to produce the first detailed charts of the Gulf of St. Lawrence region, participated in the siege of Québec and was appointed the Surveyor-General of North America. The centre courtyard off the auditorium was also completed. Numerous pieces of art created by local artists were purchased and installed about BIO.

The new Strickland, Murray and Holland Buildings were officially opened by the Honourable Romeo LeBlanc, Minister of the Department of Fisheries and Oceans (DFO), and the

Honourable Judy Erola, Minister of State of Mines, who represented the Department of Energy, Mines, and Resources (DEMR).



The laboratory wing of the Main Building was named after Dr. William van Steenburgh who was considered to be the founding father of BIO. At the same time, the office wing of the Main Building was named the Polaris Building and the Depot was named the Vulcan Building. Polaris is the North or Polar Star. Vulcan was the God of Fire in Roman Mythology, manufacturer of art, arms, iron, jewellery and armour for various gods and heroes.

1982

A second floor was added to the front and back of the Fish Lab to provide more office space.

The Hayes Boardroom was established and named after Dr. F. Ronald Hayes (1904-1982) who had been the Chairman of the Fisheries Research Board of Canada from 1964 to 1969 and oversaw the creation of the Marine Ecology Laboratory.

1984

An in-house image analysis system was installed for remote sensing and other applications.

1985

For the first time, scientists had direct access to a Cray supercomputer through the Atmospheric Environmental Service facility in Dorval, QC.

1988

The Coast Guard Marine Communications and Traffic Services Building was constructed on top of the hill.

1989

1990

A Stardent 3040 mini-supercomputer was installed for physical oceanographic modelling applications.

1992

Public Works and Government Services Canada took over the operation and maintenance of BIO facilities from the Department of Fisheries and Oceans.

Major renovations were carried out in the Polaris Building. Most interior walls were removed and space converted to the open office concept. In the process, the Sixth Floor Conference Room was removed.

1993

The scientific computing system underwent major changes, moving away from a mainframe dependence into an open system environment. An in-house, on-demand digital publishing operation was established to provide timely release of large-format colour maps and posters.

1997

The Fish Laboratory was evacuated on short notice when a serious mould condition was discovered. The building was sealed off until the problem was corrected after which the entire structure was renovated.

1998

Halifax Fisheries Research Laboratory was closed and the library was moved to BIO.

1999

The Trites Boardroom, named in honour of Dr. Ronald W. Trites (1929-1995) who had been a prominent BIO physical oceanographer, was officially dedicated in the presence of his family.

2000

Public Works and Government Services Canada, now responsible for the physical facilities, began a nine-year program of infrastructure upgrades and new buildings.

2001

The jetty was completely renovated, the first major upgrade since its construction in 1961. After forty years of exposure, the original concrete had seriously deteriorated and needed replacement. The ships' water supply lines, which frequently froze during the winter, were replaced. New lighting, electrical, and communications systems were installed to meet current code standards. The jetty's main electrical building was enlarged in anticipation of the arrival of the Canadian Coast Guard ships. A new electrical building was constructed for the marina, as well as a new tide gauge building for the Canadian Hydrographic Service.

2002

The Needler Boardroom was dedicated in the memory of Dr. George Needler (1935-2002) to honour his contributions to oceanography and international science. Members of his family were present.

The heating plant was modernized. This included the conversion from steam to hot water that reduced greenhouse gas emissions by 500,000 kg a year.

A new cooling plant was constructed to provide a centralized air conditioning system that replaced numerous individual chillers and window-mounted air conditioners. This system utilized cold Bedford Basin water, pumped from 30 m, which was passed through a heat exchanger where it cooled the water in the Institute's cooling system. One creative feature of the new building was the cultivation of prairie grass on the roof acting as insulation, moderating heat within the building itself and prolonging the life of the roofing membrane system. This was the first installation of this roofing technology on a Government of Canada facility.

2003

On September 29, Hurricane Juan hit Halifax. Damage caused by high winds and uprooted trees created havoc in transportation and electrical power transmission. Fortunately, damage to the Bedford Institute of Oceanography (BIO) campus was minor, but the facility was closed for six working days due to a downed power pole. The emergency brought out the best in BIO staff. During the post-hurricane period, the DND Route Survey Office worked on the clean-up of the grounds, the DFO Technology Services Division did an excellent job sustaining informatic systems and commissionaires and PWGSC employees calmly and competently maintained the buildings and their security.

Extensive renovations began on the north end of the Vulcan Building with particular attention given to improving workflow, safety and health in the various workshops. Planning began on the design of the new Level II laboratory building to house all laboratory work and provide an improved and safer working environment. Preparations were also well underway for the complete renovation of the Van Steenburgh Building. This building would be converted from a mix of labs, workshops and offices to a modern office complex that would accommodate scientists, technicians and administrative staff. The renovation was to start after the new Level II laboratory had been completed. Plans were also underway to renovate the Strickland Building.

2004

Work was initiated on the final phase of Vulcan Building renovations addressing the science and electronic workshops and the shipping and receiving area. Construction of the Level II laboratory began.

A wave tank facility was constructed on the shore of Bedford Basin.

2005

Work began on replacing the roofs on the Polaris, Holland, and Murray Buildings. Work also began on the design of renovations to the Van Steenburgh Building.

2006

By the end of the year, the Level II laboratory was nearly complete. Besides its high level of functionality, the new facility provided an aesthetically pleasing work environment. The design work for the renovations to the Van Steenburgh Building was completed.

2007

Reconfiguration of the Strickland and Vulcan Buildings got underway in association with the Van Steenburgh Building renovations. The Strickland Building renovations involved converting former laboratories to temporary or swing space for staff displaced while construction was being carried out in the Van Steenburgh Building. Similarly, both temporary and permanent relocations of some workshops in the Vulcan Building were necessitated by the Van Steenburgh Building renovations. The demolition and removal of the entire interior of the Van Steenburgh Building began.

2008

The new Level II laboratory building was officially opened and dedicated to the memory of Katherine (Kathy) Ellis (1953-1999) who was involved in a wide range of projects using natural and artificial radionucleotides to gain information about circulation, particle transport and sedimentation in the ocean. She was also very active in BIO events, science outreach, the community-at-large and worked toward the full participation of women in science.

Renovations to the Van Steenburgh Building continued. The BIO finger jetty was extended by 33 m and its electrical system upgraded.

2009

The renovations to the Van Steenburgh Building were completed and numerous much needed new boardrooms were added through out the Institute. Several of these were named after prominent staff. The King Boardroom was named after Dr. Lewis King (1924-2003), a geologist who led the early development of seabed habitat mapping. The Kranck Boardroom was named after Dr. Kate Kranck (1937-1993), a sedimentologist who did fundamental work on understanding flocculation processes in the sea. The Reg Sweeny Boardroom was named after Mr. Reginald Sweeney (1949-2007) who was a freshwater fisheries biologist who made many contributions to the habitat management program.

The Waterworld Gallery was opened in the lobby of the Ellis Building. It was decorated with underwater images taken by BIO staff members, primarily by R. Semple.

2010

Construction started on the new Coast Guard Building and accompanying facilities for storage and maintenance of buoys and other equipment.

2012

The Canadian Coast Guard Maritimes Headquarters Building was completed, the Parker Street base was closed and all Coast Guard staff and operations moved to the BIO campus.

The Auditorium was officially named the William L. Ford Auditorium. Dr. Ford (1913-1992) was the second director of BIO and guided its development during its formative years. A plaque was unveiled by his daughter, Arden Ford, during the 50th anniversary celebration.

A decision was made in Ottawa to close all federal marine science libraries except those at BIO and the Institute of Ocean Sciences in Sidney, BC. Plans were developed to move the library collections from Ottawa, Mont-Joli, Moncton, St. Andrews and St. John's to BIO.

SHIPS

This section documents the evolution of the principal vessels in the BIO research and survey fleet between 1962 and 2012. It provides a brief description of each ship, when it arrived and when it departed. When available, annual days at sea and nautical miles steamed are provided for individual vessels. It also lists other government and charter vessels that were used, as well as cooperative ventures carried out with oceanographic laboratories in other countries. Major modifications and events are included as well as visiting oceanographic ships. The many hydrographic launches and small boats for inshore work operated by BIO are not documented.

In the early years, the atmosphere on BIO ships was quite formal, a carryover from the long tradition of the Canadian Hydrographic Service. There was a clear distinction between scientific staff and crew, and socializing between the two was discouraged. Scientific staff ate with the officers, and jackets and ties were required for all meals. When women began going to sea in 1965, they were required to wear skirts or dresses for all meals. Duty free liquor and cigarettes were available and movies were shown in the evening on the larger ships. By the 1980s, the atmosphere on ships started to become more informal. Casual dress became acceptable for meals and duty free issues were no longer made. For a while, alcohol was banned but regulations were loosened when the Canadian Coast Guard took over operation of the fleet in 1995.

In the early years, ship time was provided without charge to Canadian universities but this practice had to be discontinued in later years when operating budgets were cut. Canadian universities were still able to use vessels but had to provide their own funding for ship time.

Throughout the years, BIO ships responded to many search and rescue calls, which saved many lives, and effectively assisted with numerous environmental emergencies.

The BIO community has been fortunate to have a fine fleet of research and survey vessels over much of its history. These vessels were operated by highly professional officers and crew who contributed much to the scientific success of BIO programs, often under quite trying weather conditions at sea. Captains of note during the early years include W.N. Kettle, W. Thorne, J.W. Taylor, S. Baggs, W.J. Vieau, P.M. Brick, M.J.A. Wagner, S. Lillington, D. Butler, D. Deer, R. Dickenson, F.W. Mauger, G. Reyno, L. Strum and J.S. Lewis.

1962

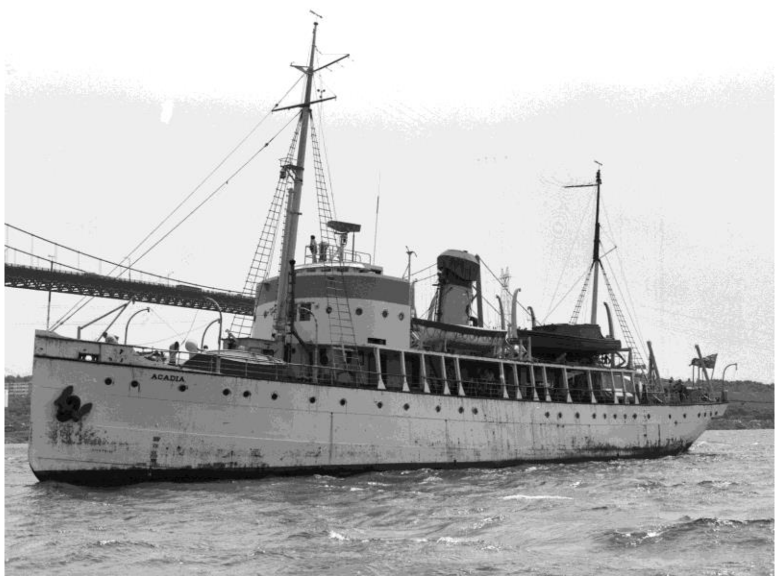
When BIO opened, it took over the operation of five vessels already in use by the Canadian Hydrographic Service and the Atlantic Oceanographic Group. They were:

- CHS *Acadia*
- CHS *Kapuskasing*
- CHS *Baffin*
- CHS *Maxwell*
- CNAV *Sackville* (RCN)

The CHS *Kapuskasing*, CHS *Baffin* and CHS *Maxwell* had operated out of Purdy's Wharf on the Halifax waterfront while the CHS *Acadia* had been based in Pictou, NS. All four hydrographic vessels returned to the new facilities at BIO at the end of the 1965 field season. The CNAV *Sackville* remained based at the Dockyard in Halifax.

The CHS *Acadia* was designed in Canada for hydrographic surveying and oceanographic research. She was built in 1913 by Swan Hunter and Wigham Richardson in Newcastle-on-Tyne, UK. The hull was ice-strengthened, she was driven by a coal-fired triple expansion steam engine and she was capable of carrying four hydrographic launches. She was twice commissioned into the Royal Canadian Navy as HMCS *Acadia*, the only ship still afloat to have served in both World Wars. The ship was notorious for the trail of black smoke billowing from her coal-fired boilers. Her vital statistics were:

Length	55 m
Displacement	1,700 tonnes
Cruising speed	13 knots
Scientific complement	15



The CHS *Kapuskasing*, originally designed as an Algerine class steam-driven minesweeper, was built by Port Arthur Shipbuilding Company in Port Arthur, ON, in 1943. She served on convoy duty out of Halifax during World War II. Following the war, she was made available on permanent loan to the Canadian Hydrographic Service and refitted for hydrographic surveys. She was capable of carrying four hydrographic launches. Her vital statistics were:

Length	67 m
Displacement	1,250 tonnes
Endurance	12 days

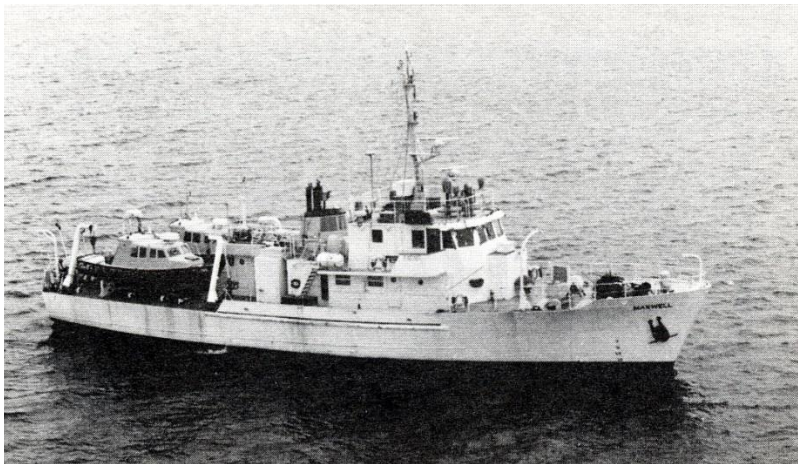
The CHS *Baffin* was a diesel-driven ship initially equipped for hydrographic surveying but later was also used for general oceanography. She was built in 1956 by Canadian Vickers in Montreal, QC, with a Lloyds Ice Class I hull to enable work in ice-infested waters. She was equipped with twin screws and a bow thruster. She was capable of carrying six hydrographic launches and a helicopter. At the time, she was the most modern hydrographic survey vessel in the world. Her vital statistics were:

Length	87 m
Displacement	4,420 tonnes
Cruising speed	13 knots
Endurance	45 days
Scientific complement	29

While on a shakedown cruise soon after delivery, she ran aground on Black Rock, just off Cape LaHave Island near Bridgewater, NS. She was later freed by tugs and towed to Halifax for inspection and repairs.

The CHS *Maxwell* was a diesel-driven ship built for inshore hydrographic surveys. She was designed by German Milne and built at Halifax Shipyards in 1960. She was delivered in 1961 and capable of carrying two hydrographic launches. Her vital statistics were:

Length	35 m
Displacement	275 tonnes
Cruising speed	10 knots
Endurance	14 days
Scientific complement	7



The CNAV *Sackville* was a Flower-class corvette built in 1941 by Saint John Dry Dock and Shipbuilding Company Ltd. in Saint John, NB. She was one of 267 corvettes built during World War II. She was driven by a triple expansion steam engine and experienced extensive action during the war while serving on North Atlantic convoy duty. Most of the Flower-class corvettes were scrapped shortly after the war but the HMCS *Sackville* was laid up in reserve. She was reactivated by the Royal Canadian Navy in 1952 and converted to a research vessel. The armament was removed and the hull repainted black in place of the original dazzle camouflage. Her vital statistics were:

Length	63 m
Displacement	1250 tonnes
Cruising speed	12 knots
Endurance	14 days
Scientific complement	11

Use was made of the CCGS *John A. MacDonald*, CCGS *Labrador* and CCGS *C.D. Howe* operated by the Canadian Coast Guard. In addition, the MV *Arctic Sealer* and MV *North Star VI* were chartered for hydrographic surveys.

The French research vessel *Thalassa* was the first foreign research vessel to visit BIO.

1963

The fleet remained the same and the hydrographic vessels were now identified as CSS:

- CSS *Acadia* (142 days, 3,619 nmiles)
- CSS *Kapuskasing* (140 days, 14,862 nmiles)
- CSS *Baffin* (164 days, 27,220 nmiles)
- CSS *Maxwell* (146 days, 5,244 nmiles)
- CNAV *Sackville* (RCN)

Use was made of the CCGS *Labrador,* CCGS *John A. MacDonald* and CCGS *d'Iberville* operated by the Canadian Coast Guard. In addition, the MV *Theta* was chartered for hydrographic surveys.

The CSS *Baffin* began to be used for general oceanographic programs as well as hydrographic surveys.

The CSS *Hudson* was delivered at the end of the year and was a wonderful Christmas present. She was a diesel-electric driven ship built at Saint John Shipbuilding and Drydock in Saint John, NB, with a Lloyds Ice Class I hull to enable work in ice-invested waters. She was equipped for multidisciplinary research projects and could carry four hydrographic launches and a helicopter. She had twin screws and a bow thruster. She soon became the queen of the fleet and an icon for BIO. Her vital statistics were:

Length	90 m
Displacement	4793 tonnes
Cruising speed	13 knots
Endurance	50 days
Scientific complement	25

The RV *Atlantis II* of the Woods Hole Oceanographic Institute visited BIO.

1964

The CSS *Hudson* was commissioned by The Honourable W. M. Benidickson, Minister of the Department of Mines and Technical Surveys.

With the arrival of CSS *Hudson*, the fleet expanded to:

- CSS *Hudson* (111 days, 23,130 nmiles)
- CSS *Acadia* (126 days, 5,198 nmiles)
- CSS *Kapuskasing* (169 days, 10,822 nmiles)
- CSS *Baffin* (275 days, 42,483 nmiles)

- CSS *Maxwell* (167 days, 4,643 nmiles)
- CNAV *Sackville* (RCN)

Use was made of the CCGS *Labrador* operated by the Canadian Coast Guard and the CNAV *Bluethroat* operated by the Royal Canadian Navy (RCN). In addition, the MV *Theta* was chartered for hydrographic surveys.

For most of the year, the CSS *Hudson* was involved in conducting sea trials and tuning equipment. In June, she sailed to Charlottetown, PEI, with CSS *Acadia* to represent BIO at the 100th Anniversary of the Charlottetown Conference.

To improve her scientific capabilities, a laboratory was built on the aft superstructure of the CNAV *Sackville.*

1965

The fleet remained the same:

- CSS *Hudson* (221 days, 46,960 nmiles)
- CSS *Acadia* (166 days, 5,321 nmiles)
- CSS *Maxwell* (170 days, 6,485 nmiles)
- CSS *Baffin* (32 days, 6,160 nmiles)
- CSS *Kapuskasing* (223 days, 21,951 nmiles)
- CNAV *Sackville* (RCN)

Use was made of the CCGS *Labrador* operated by the Canadian Coast Guard. In addition, the MV *Theta* and MV *Theron* were chartered for hydrographic surveys.

The *CSS Baffin's* season was cut short by defective propulsion gearing. Investigation revealed that wear of the bronze clutch units following eight years of arduous service was such that replacement was essential and there were delays in manufacturing the replacement parts.

Ms. Charlotte Keen and Ms. Francis Wagner of BIO and Ms. Joleen Aldous and Ms. Kai- Mai Pold of Dalhousie University were the first women to go to sea on the CCS *Hudson*.

1966

The MV *E.E. Prince*, a steel stern trawler for fisheries research, was built in Pictou, NS, and delivered to the Fisheries Research Board of Canada (FRBC). Her vital statistics were:

Length	40 m
Displacement	421 tonnes
Cruising speed	10 knots

In addition, the MV *Sigma-t* was purchased and converted for inshore work by the FRBC. Although based at BIO, both these vessels were programmed and operated by the FRBC office in Halifax.

With the arrival of MV *E.E. Prince* and MV *Sigma-t*, the fleet expanded to:

- CSS *Hudson* (142 days, 27,941 nmiles)
- CSS *Acadia* (166 days, 4,334 nmiles)
- CSS *Maxwell* (192 days, 6,619 nmiles)
- CSS *Baffin* (257 days, 43,953 nmiles)
- CSS *Kapuskasing* (193 days, 22,996 nmiles)
- CNAV *Sackville* (RCN)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)

Four new Bertram fiberglass launches were delivered. Use was made of the CCGS *Labrador* operated by the Canadian Coast Guard. In addition, the MV *Theta* was chartered for hydrographic surveys. Modifications were made to the scientific accommodations on CSS *Hudson* that increased the number of berths to 28.

A fire in the engine room of the CSS *Hudson* caused extensive damage and made it necessary to cancel the program for the rest of the year.

While working out of Antigua early in the year, the CSS *Baffin* provided anchorage, weather and other information to the Royal Yacht *Britannia* on her visit to the island with Her Majesty the Queen and His Royal Highness the Duke of Edinburgh on board. Senior officers had the honour of being presented to the Royal Couple at a reception ashore.

1967

The fleet remained the same:

- CSS *Hudson* (194 days, 28,907 nmiles)
- CSS *Acadia* (143 days, 3,436 nmiles)
- CSS *Maxwell* (172 days, 6,346 nmiles)
- CSS *Baffin* (266 days, 43,908 nmiles)
- CSS *Kapuskasing* (153 days, 23,848 nmiles)
- CNAV *Sackville* (RCN)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)

Some work was done using the MV *Harengus* based in St. Andrews and the CCGS *Labrador* operated by the Canadian Coast Guard. In addition, the MV *Whip-the-Wind* was chartered for the St. Margaret's Bay program and the MV *Theta* was chartered for hydrographic surveys.

As part of Canadian Centennial Year celebrations, the CSS *Baffin* sailed to Monaco and represented Canada at the Ninth International Hydrographic Conference while the CCS *Hudson* traveled to Montreal to be on display for several weeks at the Expo 67 World's Fair.

Extensive modifications were made on the CNAV *Sackville* including enclosing the bridge.

The first general-purpose minicomputer, a Digital Equipment Corporation PDP-8 with 4 K memory, was installed on CSS *Baffin*.

1968

The CSS *Dawson* arrived and was commissioned as the newest member of the fleet. She was a diesel-driven ship built in 1967 in the George T. Davie & Sons Shipyard in Lauzon, QC, for multipurpose oceanographic research, especially on the continental shelf. With her low well deck, she was particularly well suited for handling bulky equipment over the side such as current meter moorings. She was equipped with twin screws, variable pitch propellers and a bow thruster. She was named after William Bell Dawson (1854-1944), an engineer and superintendent of the Canadian Tidal Survey for many years. Her vital statistics were:

Length	64 m
Displacement	1975 tonnes
Cruising speed	13 knots
Endurance	45 days
Scientific complement	13

The MV *Navicula*, a wooden-hulled vessel expressly designed for inshore programs, was delivered and began operations in St. Margaret's Bay. Her vital statistics were:

Length	20 m
Displacement	110 tonnes
Cruising speed	10 knots

She was programmed and operated by the Fisheries Research Board of Canada office in Halifax.

With the arrival of CSS *Dawson* and MV *Navicula* , the fleet expanded further to include:

- CSS *Hudson* (236 days, 39,179 nmiles)
- CSS *Acadia* (168 days, 3,883 nmiles)
- CSS *Maxwell* (167 days, 7,283 nmiles)
- CSS *Baffin* (235 days, 41,831 nmiles)
- CSS *Dawson* (109 days, 20,000 nmiles)
- CSS *Kapuskasing* (195 days, 23,895 nmiles)
- CNAV *Sackville* (RCN)
- MV *E.E. Prince* (FRBC) (14 days, 800 nmiles)
- MV *Sigma-t* (FRBC)
- MV *Navicula* (FRBC)

Some work was done using the MV *Harengus* based in St. Andrews, the CCGS *d'Iberville* operated by the Canadian Coast Guard and the CNAV *Bluethroat* operated by the Royal Canadian Navy. In addition, the MV *Theta,* MV *Ambrose Foote,* MV *Fairmorse* and MV *Brandal* were chartered for hydrographic surveys and the MV *Whip-the-Wind* was chartered for the St. Margaret's Bay program. The MV *Brandal* was also chartered for plankton surveys.

BIO ships started to use satellite navigation and delivery was taken of two Transit Satellite System receivers.

1969

The fleet remained the same:

- CSS *Hudson* (150 days, 27,943 nmiles)
- CSS *Acadia* (161 days, 4,634 nmiles)
- CSS *Maxwell* (181 days, 4,534 nmiles)
- CSS *Baffin* (248 days, 36,463 nmiles)
- CSS *Dawson* (161 days, 30,295 nmiles)
- CSS *Kapuskasing* (156 days, 18,219 nmiles)
- CNAV *Sackville* (RCN) (144 days, 24,271 nmiles)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)
- MV *Navicula* (FRBC)

Use was made of the CCGS *d'Iberville* and the *CCGS John A. MacDonald* operated by the Canadian Coast Guard. In addition, the MV *Theta*, MV *Ambrose Foote*, MV *Fairmorse* and MV *Brandal* were chartered for hydrographic surveys.

In November, the CSS *Hudson* departed on the Hudson 70 Expedition.

The CSS *Acadia* completed her final cruise in November. She was moored alongside the Institute and opened to visitors until she was moved to the Maritime Museum of the Atlantic in Halifax in 1981.

1970

With the retirement of CSS *Acadia*, the fleet was reduced to:

- CSS *Hudson* (289 days, 42,332 nmiles)
- CSS *Maxwell* (155 days, 7,461 nmiles)
- CSS *Baffin* (196 days, 25,578 nmiles)
- CSS *Dawson* (172 days, 35,697 nmiles)
- CSS *Kapuskasing* (148 days, 12,225 nmiles)
- CNAV *Sackville* (RCN) (131 days, 19,968 nmiles)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)
- MV *Navicula* (FRBC)

Use was made of the CCGS *C.D. Howe*, CCGS *Labrador* and CCGS *John A. MacDonald* operated by the Canadian Coast Guard.

The CSS *Hudson* continued on the Hudson 70 Expedition with ports of call in Rio de Janerio, Buenos Aires, Punta Arenas, Valparaiso, Tahiti, Vancouver, Victoria and Tuktoyaktuk. After traversing the Northwest Passage, she arrived home at BIO in October. The Honourable J. J. Greene was on hand to greet the ship and to bring a congratulatory message from the Governor-General. She became the first ship to circumnavigate the Americas. During this 11-month epic voyage, she sailed 55,000 miles, carried 122 scientific staff and generated an impressive body of unique oceanographic data. Medals commemorating the historic event were presented to all participants.

The CSS *Baffin* circumnavigated North America. After passing through the Panama Canal and steaming up the Pacific and through the Bering Straits, she joined CSS *Hudson* to conduct surveys in the Beaufort Sea. She and the CSS *Hudson* returned together through the Northwest Passage.

1971

The fleet remained the same:

- CSS *Hudson* (224 days, 29,996 nmiles)
- CSS *Maxwell* (166 days, 5,981 nmiles)
- CSS *Baffin* (236 days, 31,961 nmiles)
- CSS *Dawson* (139 days, 21,953 nmiles)
- CSS *Kapuskasing* (160 days, 10,136 nmiles)
- CNAV *Sackville* (RCN) (125 days, 17,386 nmiles)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)
- MV *Navicula* (FRBC)

The CNAV *Bluethroat*, operated by the Royal Canadian Navy, was used while the CCGS *John A. MacDonald* and CCGS *Labrador*, operated by Canadian Coast Guard, carried hydrographic survey parties.

1972

The fleet remained the same:

- CSS *Hudson* (130 days, 24,249 nmiles)
- CSS *Maxwell* (172 days, 5,493 nmiles)
- CSS *Baffin* (199 days, 13,261 nmiles)
- CSS *Dawson* (181 days, 29,692 nmiles)
- CSS *Kapuskasing* (126 days, 10,164 nmiles)
- CNAV *Sackville* (RCN) (130 days, 16,721 nmiles)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)
- MV *Navicula* (FRBC)

The CNAV *Bluethroat*, operated by the Royal Canadian Navy, was used. Some work was done using the MV *Harengus* based in St. Andrews. The MV *Minna* and MV *Christmas Seal* were chartered for hydrographic surveys. The CCGS *Louis S. St-Laurent* and CCGS *Labrador,* operated by the Canadian Coast Guard, were also used for hydrographic surveys.

The CNAV *Kapuskasing* was retired after its final cruise and returned to the Department of National Defence.

Rho-rho Loran-C was used for more accurate and reliable positioning of BIO ships in offshore hydrographic and geophysical surveys.

Satellite navigation was becoming standard on BIO ships. A PDP-11 computer was installed on CSS *Hudson* for navigation purposes.

Visiting ships included the *Vilikitsky*, *Liman* and *Kolequev* of the USSR, the RV *Trident* from the University of Rhode Island, the *Wymen* from the US Navy and the RV *Cirolana* from the UK.

1973

With the retirement of the CSS *Kapuskasing*, the fleet was reduced to:

- CSS *Hudson* (250 days, 34,3145 nmiles)
- CSS *Maxwell* (218 days, 6,252 nmiles)
- CSS *Baffin* (243 days, 25,053 nmiles)
- CSS *Dawson* (215 days, 32,604 nmiles)
- CNAV *Sackville* (RCN) (138 days, 20,444 nmiles)
- MV *E.E. Prince* (FRBC)
- MV *Sigma-t* (FRBC)
- MV *Navicula* (FRBC)

The MV *Minna*, MV *Theron* and the MV *Christmas Seal* were chartered for hydrographic surveys.

The programming and operation of the three Fisheries Research Board of Canada (FRBC) vessels was transferred to the Ships Division at BIO when the operational activities of FRBC were terminated and the Halifax office closed.

1974

The fleet remained the same:

- CSS *Hudson* (207 days, 34,451 nmiles)
- CSS *Maxwell* (243 days, 7,653 nmiles)
- CSS *Baffin* (221 days, 26,460 nmiles)
- CSS *Dawson* (153 days, 19,575 nmiles)
- CNAV *Sackville* (RCN) (131 days, 16,961 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*

The MV *Minna*, MV *Theron* and the MV *Christmas Seal* were chartered for hydrographic surveys. The Victoria-based weather ship CCGS *Quadra* was used by BIO staff in the GARP

Atlantic Tropical Experiment. The Easter Arctic Survey made use of the CCGS *John A. MacDonald*, CCGS *Norman McLeod Roger*, CCGS *Labrador* and CCGS *Louis S. St-Laurent* for track sounding.

Women were employed for the first time on ship's crews, beginning on CSS *Hudson*.

The CSS *Baffin* undertook a production/training survey cruise off the coast of Guyana in South America.

The CSS *Baffin* was redesignated from a registered passenger vessel to a cargo vessel, which reduced maintenance costs and allowed her to carry explosives.

The charter vessel MV *Minna* ran aground at Resolution Island, NWT. Attempts to salvage her failed and the vessel sank.
Studies on the cost and effectiveness of charter vessels compared to government ships indicated that costs were less for charter vessels but that the number of suitable vessels available for charter in Canada was very restricted.

1975

The fleet remained the same:

- CSS *Hudson*
- CSS *Maxwell*
- CSS *Baffin*
- CSS *Dawson*
- CNAV *Sackville* (RCN)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*

Use was made of the CCGS *John A. MacDonald*, CCGS *Louis S. St. Laurent*, CCGS *Labrador* and CCGS *d'Iberville*, operated by the Canadian Coast Guard, as well as three charter vessels.

The CNAV *Sackville* made her final cruise for BIO. However, she continued to be used by the Defense Research Establishment Atlantic until decommissioned in 1982.

The bridge of the CSS *Hudson* was rebuilt and fully enclosed. The renovations provided a better view of over-the-side operations and significantly reduced the operating fatigue for watchstanders.
The submersible *Pisces IV* was borrowed from the Institute of Ocean Sciences, Patricia Bay, Sidney, BC, for use in studies of St. Margaret's Bay, N.S.

1976

With the retirement of CNAV *Sackville*, the fleet was reduced to:

- CSS *Hudson*

- CSS *Maxwell*
- CSS *Baffin*
- CSS *Dawson*
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*

Use was made of the CCGS *Labrador* operated by the Canadian Coast Guard. In addition, the MV *Christmas Seal* and the MV *Northern Seal* were chartered for hydrographic surveys. Unfortunately, the wooden-hulled MV *Christmas Seal* caught fire and sank three hours from Halifax but all hands were rescued.

While working in Lancaster Sound, the CSS *Hudson* lost a propeller which reduced her capability in ice and affected the scientific program.

The CSS *Hudson* rescued all crewmembers from the Fisheries Patrol Vessel *Cape Freels* that caught fire and sank off Newfoundland.

The CSS *Acadia*, still moored at BIO, was designated a National Historical Monument.

1977

The fleet remained the same:

- CSS *Hudson*
- CSS *Maxwell*
- CSS *Baffin*
- CSS *Dawson*
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*

The CCGS *Labrador*, CCGS *John A. MacDonald* and CCGS *d'Iberville*, operated by the Canadian Coast Guard, were used and the MV *Martin Karlsen* and MV *Meta* were chartered. The CSS *Baffin* worked off the coast of Peru as part of a CIDA-sponsored Peruvian fishing project. Later on, she was severely damaged by ice while attempting to reach her survey area in Victoria Strait, Nuvavut.

1978

The MV *Lady Hammond*, a converted fishing trawler built in 1972, was acquired on long-term charter to conduct groundfish trawl surveys for the newly established Marine Fish Division. Her vital statistics were:

Length	54 m
Displacement	306 tonnes
Cruising speed	12 knots

With the arrival of the MV *Lady Hammond*, the fleet expanded to:

- CSS *Hudson*
- CSS *Maxwell*
- CSS *Baffin*
- CSS *Dawson*
- MV *E.E. Prince*
- MV *Sigma-t*
- MV N*avicula*
- MV *Lady Hammond* (charter)

Use was made of the CCGS *Labrador*, CCGS *d'Iberville*, CCGS *Louis St. Laurent* and CCGS *John A. MacDonald* operated by the Canadian Coast Guard. In addition, the MV *Martin Karlsen*, MV *Meta*, MV *Gulf Star*, MV *Anne Jolene II*, MV *Pubnico Libra*, MV *Scotia Point*, MV *Canso Condor* and MV *Oran II* were chartered for various hydrographic, geophysical and oceanographic studies.

The CSS *Baffin* underwent a midlife refit to improve her capabilities for hydrographic surveys, oceanographic research and operations in ice.

1979

The fleet remained the same:

- CSS *Hudson* (224 days, 21,214 nmiles)
- CSS *Maxwell* (171 days, 7,908 nmiles)
- CSS *Baffin* (133 days, 15,232 nmiles)
- CSS *Dawson* (215 days, 27,875 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*
- MV *Lady Hammond* (charter)

The MV *Meta*, MV *Alert*, MV *Daring* and MV *Lacuna* were chartered for hydrographic and geophysical surveys. In addition, the Marine Fish Division carried out cooperative cruises with the USSR research vessel *Viandra*.

1980

The fleet remained the same:

- CSS *Hudson* (226 days, 37,180 nmiles)
- CSS *Maxwell* (194 days, 14,597 nmiles)
- CSS *Baffin* (176 days, 18,312 nmiles)
- CSS *Dawson* (248 days, 30,905 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*
- MV *Lady Hammond* (charter)

The MV *Gulfstar* was chartered for hydrographic and geophysical surveys and hydrographic surveys were carried out from various Coast Guard vessels on the Eastern Arctic project. In addition, the Marine Fish Division carried out cooperative cruises with four USSR research vessels: *Viandra*, *Argus*, *Let* and *Antares*. The MV *Alert* was chartered for oil sampling on the Scotian Shelf.

The charter vessel MV *Pandora II*, a converted offshore supply ship, arrived at the end of the year on loan from the Pacific Region. She was equipped with the *Pisces IV* manned submersible.

Captain Jacques Yves Cousteau and his vessel *Calypso* visited on the way to do filming in the Great Lakes.

The RRS *Discovery*, from the British National Institute of Oceanography, visited on the way home from working in the Pacific.

1981

The fleet remained the same:

- CSS *Hudson* (245 days, 34,034 nmiles)
- CSS *Baffin* (211 days, 22,281 nmiles)
- CSS *Dawson* (228 days, 36,635 nmiles)
- CSS *Maxwell* (188 days, 8,530 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*
- MV *Lady Hammond* (charter)

The MV *Polar Circle* was chartered for hydrographic and geophysical surveys and hydrographic surveys were carried out using various Coast Guard vessels. In addition, the Marine Fish Division carried out cooperative cruises with the USSR research vessel *Ekliplika*.

The CSS *Hudson* circumnavigated North America on a nine-month expedition, passing through the Panama Canal. Enroute she undertook a survey of a shipping corridor in the Beaufort Sea. This was her second time through the Northwest Passage.

The CSS *Hudson* was equipped with two HP 2100 and one PDP 8E computers. The CSS *Baffin* was equipped with two HP 1000 computer systems.

The CSS *Acadia* was moved to the Maritime Museum of the Atlantic in Halifax to become part of the permanent collection. After restoration work, she was opened to visitors.

The MV *Pandora II*, equipped with *Pisces* IV, carried out an extensive program between April and December and returned to the Pacific Region at the end of the year.

The MV *Whiting*, a NOAA survey vessel from Norfolk, VA, visited.

1982

The new research trawler MV *Alfred Needler* was delivered. This diesel-driven vessel, built at Ferguson Industries Ltd. in Pictou, NS, was designed for fisheries research. She was named after Dr. Alfred W. Needler (1906-1998) who had been a well-known Canadian fisheries scientist and administrator. Her vital statistics were:

Length	50 m
Displacement	925 tonnes
Cruising speed	12 knots
Endurance	30 days
Scientific complement	10

With the arrival of the MV *Alfred Needler*, the fleet expanded to:

- CSS *Hudson* (239 days, 35,412 nmiles)
- CSS *Baffin* (164 days, 20,657 nmiles)
- CSS *Dawson* (211 days, 22,681 nmiles)
- CSS *Maxwell* (109 days, 9,902 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula* (163 days, 5,228 nmiles)
- MV *Alfred Needler*
- MV *Lady Hammond* (charter)

Numerous small vessels were chartered for various projects. In addition, the Marine Fish Division carried out cooperative cruises with the USSR research vessel *Ekliplika*.
The CSS *Baffin* completed an extensive mid-life refit. Hydrographic operations were greatly improved, as was the capability to carry out oceanographic research operations. Accommodations for all staff were substantially improved.

The CSS *Dawson* went aground on the Magdelan Shallows while responding to a request to assist the CCGS *Provo Wallis*, which had previously grounded while changing buoys at the harbour entrance. She was pulled free a few days later by the CCGS *Jackman.*
The first non-military use of the NAVSTAR Global Positioning System was undertaken on the CSS *Hudson.*

The CSS *Hudson* responded to a search and rescue call and steamed to the *Ocean Ranger* on the Grand Banks during a severe storm. Unfortunately, the semi-submersible drilling platform had capsized and sunk by the time she arrived. She spent a day performing recovery operations before diverting to St. John's to land recovered bodies.

1983

The fleet remained the same:

- CSS *Hudson*
- CSS *Baffin*
- CSS *Dawson*
- CSS *Maxwell*
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*
- MV *Alfred Needler*
- MV *Lady Hammond* (charter)

The MV *Quest,* operated by the Royal Canadian Navy, was chartered for geophysical surveys. In addition, the Marine Fish Division carried out cooperative cruises with the USSR research vessel *Let Kievu.*

The CNAV *Sackville,* now moored at the Maritime Museum of the Atlantic in Halifax, was transferred to the Canadian Naval Corvette Trust (now the Canadian Naval Memorial Trust) and restored to her 1944 wartime appearance. She was the only one of the 267 Flower class corvettes built during World War II to survive and end up in a museum.

1984

The fleet remained the same:

- CSS *Hudson* (225 days, 30,978 nmiles)
- CSS *Baffin* (231 days, 29,870 nmiles)
- CSS *Dawson* (244 days, 25,809 nmiles)
- CSS *Maxwell* (167 days, 5,683 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula*
- MV *Alfred Needler*
- MV *Lady Hammond* (charter)

The MV *Gadus Atlantica* was chartered for fisheries surveys. In addition, the Marine Fish Division carried out cooperative cruises with the USSR research vessel *Let Kievu.*

1985

The fleet remained the same:

- CSS *Hudson* (224 days, 28,838 nmiles)
- CSS *Baffin* (211 days, 32,140 nmiles)
- CSS *Dawson* (204 days, 24,606 nmiles)
- CSS *Maxwell* (180 days, 2,513 nmiles)
- MV *E.E. Prince*
- MV *Sigma-t*
- MV *Navicula* (168 days, 3,445 nmiles)
- MV *Alfred Needler*
- MV *Lady Hammond* (charter)

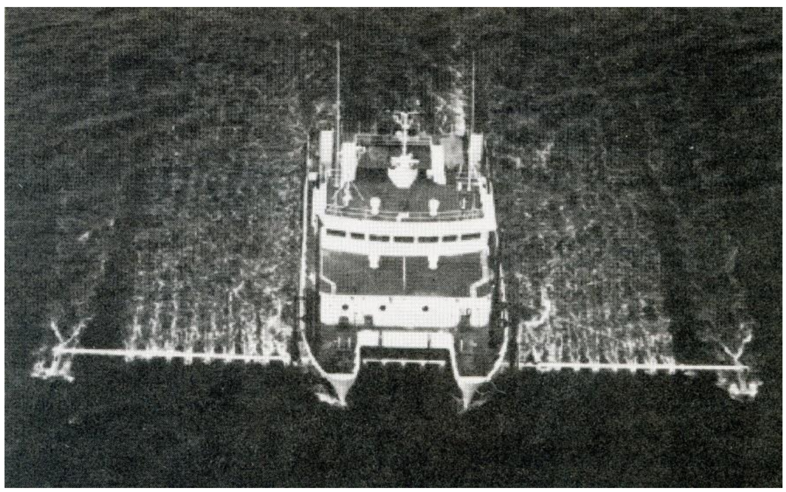
The Marine Fish Division carried out cooperative cruises with the USSR research vessel *Tava.*

The MV *Pandora II*, equipped with *Pisces IV*, made another visit to BIO and was used in numerous programs ranging from the Scotian Shelf to Baffin Island before returning to the Pacific Region at the end of the year.

1986

The new acoustic sweep vessel CSS *F.G.C. Smith*, constructed in the Georgetown Shipyards, PEI, arrived. She was a unique catamaran built to operate a multi-transducer acoustic sweep system. This pioneering vessel provided hydrographers the capability to obtain 100% bottom coverage in critical navigation channels and harbours.
Her vital statistics were:

Length	35 m
Displacement	370 tonnes
Cruising speed	10 knots
Endurance	7 days
Scientific complement	4



With the arrival of the CSS *F.G.C. Smith*, the fleet expanded to:

- CSS *Hudson* (190 days, 27,489 nmiles)
- CSS *Baffin* (214 days, 16,498 nmiles)
- CSS *Dawson* (203 days, 25,985 nmiles)
- CSS *Maxwell* (180 days, 2,020 nmiles)
- CSS *F.C.G. Smith* (97 days, 4,387 nmiles)
- MV *E.E. Prince* (208 days, 22,290 miles)
- MV *Sigma-t*
- MV *Navicula* (101 days, 5,259 nmiles)
- MV *Alfred Needler* (203 days, 29,671 nmiles)
- MV *Lady Hammond* (charter) (221 days, 30,718 nmiles)

Use was made of the CCGS *Nahidik* operated by the Canadian Coast Guard. Cooperative research cruises were carried out with three US research vessels: the RV *Atlantis II*, the RV *Albatross IV* and the RV *Edwin Link* equipped with a manned submersible. Use was also made of the USSR *Torok*.

New Digital Equipment MicroVAX II computer systems were installed on ships to enhanced shipboard data acquisition and analysis capabilities.

The CSS *Hudson* rescued the crew of a foundering large bulk carrier under hurricane conditions on the Grand Banks.

1987

The CSS *Maxwell* was transferred to the Newfoundland Region.

With the transfer of the CSS *Maxwell*, the fleet was reduced to:
- CSS *Hudson* (196 days, 30,613 nmiles)
- CSS *Baffin* (187 days, 20,730 nmiles)
- CSS *Dawson* (202 days, 28,481 nmiles)
- CSS *F.G.C. Smith* (102 days, 4,869 nmiles)
- MV *E.E. Prince* (180 days, 20,749 nmiles)
- MV *Sigma-t*
- MV *Navicula* (116 days, 5,715 nmiles)
- MV *Alfred Needler* (214 days, 28,827 nmiles)
- MV *Lady Hammond* (charter) (173 days, 24,500 nmiles)

The German FS *Polarstern*, with BIO staff aboard, reached 86° 11' N, the most northerly point ever reached by a research vessel.

The CSS *Hudson* saved all 24 crewmembers of the MV *Skipper I* when she sank in the North Atlantic.

1988

The fleet remained the same:
- CSS *Hudson* (140 days, 17,588 nmiles)
- CSS *Baffin* (248 days, 35,252 nmiles)
- CSS *Dawson* (204 days, 26,801 nmiles)
- CSS *F.G.C. Smith* (109 days, 4,894 nmiles)
- MV *E.E. Prince* (202 days, 23,973 nmiles)
- MV *Sigma-t*
- MV *Navicula* (144 days, 8,209 nmiles)
- MV *Alfred Needler* (235 days, 32,515 nmiles)
- MV *Lady Hammond* (charter) (167 days, 23,198 nmiles)

Use was made of the CCGS *Nahidik*, CCGS *Narwal* and CCGS *John A. MacDonald* operated by the Canadian Coast Guard as well as the CSS *Louis M. Lauzier* operated by the DFO Quebec Region. The MV *Pholas* was charted for geotechnical surveys. Cooperative research cruises were carried out using the MV *Skogafoss* from Iceland, the RV *Somerset* from the UK, the RV *Columbus Iselin* from the US and the RV *Saulkrasty* from the USSR.

The first multibeam echo sounder, a Simrad EM100 system, was installed on the CSS *Frederick G. Creed*.

The CSS *Hudson* found the burning wreckage of the *Athenian Venture*, a tanker carrying gasoline which exploded and broke into two off Newfoundland while enroute from Amsterdam to New York. At the time of the explosion, the *Hudson* was about three steaming hours away but could see the fire in the night sky as they approached. There were no survivors.

1989

The fleet remained the same:

- CSS *Hudson* (63 days, 9,801 nmiles)
- CSS *Baffin* (180 days, 18,585 nmiles)
- CSS *Dawson* (163 days, 23,201 nmiles)
- CSS *F.G.C. Smith* (89 days, 4,342 nmiles)
- MV *E.E. Prince* (169 days, 19,373 nmiles)
- MV *Sigma-t*
- MV *Navicula* (141 days, 8,695 nmiles)
- MV *Alfred Needler* (211 days, 26,038 nmiles)
- MV *Lady Hammond* (charter) (174 days, 24,585 nmiles)

Use was made of HMCS *Cormorant* operated by the Royal Canadian Navy, the CCGS *Nahidik* operated by the Canadian Coast Guard and the CSS *Louis M. Lauzier* operated by the DFO Quebec Region. Cooperative research cruises were carried out using the RV *Casanice* from France and the RV *Maltsevo* from the USSR.

The CSS *Hudson* completed her mid-life refit. The many improvements would enable the vessel to provide continuing service to the Atlantic scientific community for many years to come.

Trials with the Hysub 5000 Remotely Operated Vehicle were held using the CSS *Dawson*.

The newly built SWATH (small waterplane area twin hull) survey vessel CSS *Frederick G. Creed* arrived at BIO for a three-month period to assess her capability for hydrographic surveys, scientific research, and fisheries patrol before she was transferred to the Quebec Region.

1990

The fleet remained the same:

- CSS *Hudson* (206 days, 30,008 nmiles)
- CSS *Baffin* (201 days, 20,705 nmiles)
- CSS *Dawson* (172 days, 22,037 nmiles)
- CSS *F.G.C. Smith* (92 days, 3,685 nmiles)
- MV *E.E. Prince* (185 days, 23,599 nmiles)
- MV *Sigma-t*
- MV *Navicula* (116 days, 6,590 nmiles)

- MV *Alfred Needler* (188 days, 25, 419 nmiles)
- MV *Lady Hammond* (charter) (177 days)

Use was made of the CSS *F.C.G. Creed* operated by the DFO Quebec Region. Cooperative research cruises were carried out using the MV *Skogaloss* from Iceland, the RV *Alcor* and RV *Meteor* from Germany, the RV *Maltsevo* and RV *Evrika* from the USSR and the RV *Meetpost Noordivik* from the Netherlands.

At the end of the year, the CSS *Baffin* bumped against the BIO jetty while docking during a severe storm and her hull was badly damaged. She was never able to sail again under her own power.

1991

Early in the year, the CSS *Baffin* was decommissioned after 34 years of service. This marked the end of offshore and arctic hydrographic surveys at BIO. To partially make up for her loss, the CSS *Matthew* was transferred to BIO from the Newfoundland Region. In addition, a portion of the CSS *Baffin* budget was transferred to CHS for shore party surveys and the CSS *Hudson* was made available for hydrographic surveys every fourth year.

The CSS *Matthew* arrived. She was designed as a hydrographic survey vessel and constructed in 1990 at Versatile Pacific Shipyards in North Vancouver, BC. She was equipped with an EM100 multibeam sounding system. Her vital statistics were:

Length	51 m
Displacement	745 tonnes
Cruising speed	10 knots
Endurance	20 days
Scientific complement	7

With the loss of CSS *Baffin* and addition of CSS *Matthew*, the fleet was now:

- CSS *Hudson* (238 days, 32,424 nmiles)
- CSS *Dawson* (192 days, 24,396 nmiles)

- CSS *Matthew* (103 days, 5,662 nmiles)
- CSS *F.G.C. Smith* (66 days, 766 nmiles)
- MV *E.E. Prince* (172 days, 20,535 nmiles)
- MV *Sigma-t*
- MV *Navicula* (138 days, 7,766 nmiles)
- MV *Alfred Needler* (215 days, 29,071 nmiles)
- MV *Lady Hammond* (charter) (151 days)

The MV *Scotia Surf*, the MV *Arctic*, the MV *Lady Eileen*, the MV *Lady Sharrell* and the MV *Grenfell* were chartered for various programs. Cooperative research cruises were carried out using the MV *Skogaloss* from Iceland, the RV *Laurentian* and the RV *Cape Hatteras* from the US, the IB *Oden* from Sweden, the FS *Polarstern* from Germany, the RV *Minerva* from Italy and the RV *Maltsevo* from the USSR.

At the end of the year, the CSS *Dawson* was also retired from active service and replaced by her sister ship, the CSS *Parizeau*, transferred from DFO's Pacific Region. This diesel-driven ship was designed for multidisciplinary oceanographic research, hydrographic surveying and handling moorings. She was built in 1967 by the Burrard Dry Dock Company in North Vancouver, BC. She was equipped with twin screws, variable pitch propellers and a bow thruster. She was named after Henri Dalpe Parizeau, a prominent Canadian hydrographer. Her vital statistics were almost identical to CSS *Dawson*:

Length	64 m
Displacement	2048 tonnes
Cruising speed	12 knots
Endurance	45 days
Scientific complement	13

1992

The CSS *J.L. Hart*, a 20 m inshore research vessel designed for fisheries research and built in 1974, was transferred to BIO from St. Andrews. Her vital statistics were:

Length	20 m
Displacement	109 tonnes
Cruising speed	9 knots
Endurance	8 days
Scientific complement	3

With the arrival of CSS *Parizeau* and CSS *J.L. Hart*, the fleet expanded to:

- CSS *Hudson*
- CSS *Parizeau*
- CSS *Matthew*
- CSS *F.G.C. Smith*
- CSS *E.E. Prince*
- CSS *Sigma-t*
- CSS *Navicula*
- CSS *Alfred Needler*
- CSS *J.L. Hart*
- MV *Lady Hammond* (charter)

Use was made of the CCGS *Griffon* and CCGS *Mary Hitchens* operated by the Canadian Coast Guard and the CSS *John P. Tully* operated by the DFO Pacific Region. The MV *Brannetelle,* the MV *Betty R* and the MV *Miramichi Surveyor* were chartered for various programs. Cooperative research cruises were carried out with the RV *Oceanus* and the RV *Joides Resolution* from the US, the RV *Heinke* from Germany and the RV *Geolog Fersman* from Russia.

The MV *Lady Hammond* was retired at the end of the year.

1993

With the retirement of MV *Lady* Hammond, the fleet was reduced to:

- CSS *Hudson*
- CSS *Parizeau*
- CSS *Matthew*
- CSS *F.C.G. Smith*
- CSS *Navicula*
- CSS *Sigma-t*
- CSS *E.E. Prince*
- CSS *Alfred Needler*
- CSS *J.L. Hart*

Use was made in Lake Ontario and elsewhere of the CCGS *Griffon* operated by the Canadian Coast Guard, the CSS *Wilfred Templeman* operated by the Newfoundland Region, the CSS *John P. Tully* operated by the DFO Pacific Region and the HMCS *Mooresby* operated by the Royal Canadian Navy. The MV *William R*, the MV *D.A Moore*, the MV *April & Collett*, the MV *Petrel V* and the MV *Tignish Sea* were chartered for various programs. Cooperative research cruises were carried out using the RV *Joides Resolution*, the RV *Sea Diver* and the RV *Polar Star* from the US, the RV *Geolog Fersman* from Russia, the RV *Lance* from Norway and the MV *Lough Beltra* from Italy.

LASMO supply vessels were used to sample drilling wastes at the Copan oil development site on Sable Island Bank.

At the end of the year, the CSS *F.C.G. Smith* was transferred to the DFO Quebec Region. In exchange, the Quebec Region made the CSS *F.G.C. Creed* available to Maritimes Region for several months each year. This arrangement, where the vessel funding remained in Quebec Region, protected the CSS *F.G.C. Creed* from the Maritimes Region's vessel funding shortfalls.

The CSS *Hudson* was badly damaged by an iceberg while working in a fjord along the east coast of Greenland.
The Russian research vessel RV *Akademic Mstislav Keldysh* visited for several days for discussions on deep-ocean research topics between Canadian and Russian scientists.

1994

With the transfer of CSS *F.C.G. Smith* to the Quebec Region, the fleet was reduced to:

- CSS *Hudson*
- CSS *Parizeau*
- CSS *Matthew*
- CSS *Navicula*
- CSS *Sigma-t*
- CSS *E.E. Prince*
- CSS *Alfred Needler*
- CSS *J.L. Hart*

The CSS *Wilfred Templeman* from the Newfoundland Region was used again in an otter trawling experiment and the CSS *F.C. G. Creed* from Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. The CCGS *Louis S. St. Laurent*, operated by the Canadian Coast Guard, was used to conduct a transect across the Arctic Ocean. The CCGS *Namao* was used in Lake Winnipeg and CCGS *Samuel Risley* conducted geoscience research in the Great Lakes. The MV *Grace and Benjamin* was chartered for fisheries programs. Cooperative research cruises were carried out using the RS *Discovery* from the UK and RV *Meteor* from Germany.

At the end of the year, the CSS *E.E. Prince* was retired after 28 years of fisheries research.

The CCGS *Louis St. Laurent* became the first Canadian ship to reach the North Pole.

1995

The operation of BIO research vessels was taken over by the Canadian Coast Guard when it transferred to the Department of Fisheries and Oceans and the fleets were merged to achieve efficiencies. Soon after, the vessels, which had traditionally been painted white, were painted red and white according to Coast Guard practice. Even the models in the BIO lobby were painted the new colours. They were now identified as Canadian Coast Guard Ships (CCGS). As part of this reorganization, the Coast Guard lay day system was introduced. In the past, there had been one crew on each ship divided into three watches. Under the new system, each vessel had two crews and each was divided into two watches while at sea. The two crews rotated every 30 days. While more costly, this new system gave the crews more time off and improved shipboard morale considerably.

With the retirement of CSS *E.E. Prince*, the fleet was reduced to:

- CCGS *Hudson*
- CCGS *Parizeau*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Sigma-t*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The CCGS *Wilfred Templeman* from the Newfoundland Region was used again in an otter trawling experiment and the CCGS *F.C.G. Creed* from Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. Use was made of the CCGS *Simon* Fraser, CCGS *Louis St. Laurent* and CCGS *Mary Hichens* operated by the Canadian Coast Guard. HMCS *Cormorant*, operated by the Royal Canadian Navy, was used to work with the SDL-1 submersible. The MV *Cody,* the MV *Kathryn*, the MV *Foxy Lady* and the MV *Ceilidh Time* were chartered for various programs. Cooperative research cruises were carried out using the RV *Onrust,* RV *Seward Johnson* and the MV *Laurentian* from the US and the RV *Sonne* from Germany.

1996

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Parizeau*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Sigma-t*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region’s time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. Field programs were conducted on Canadian Coast Guard vessels from other DFO regions, vessels of opportunity and research vessels of other countries. Use was made of the FS *Polarstern* from Germany.

1997

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Parizeau*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Sigma-t*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. The CCGS *Louis S. St. Laurent* was used to conduct surveys in the Canadian Archipelago and the Canada Basin in the Arctic Ocean. In addition, scientists conducted programs on Canadian Coast Guard vessels from other DFO regions, vessels of opportunity and research vessels of other countries.

1998

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Parizeau*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Sigma-t*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. Field programs were conducted on Canadian Coast Guard vessels from other DFO regions, vessels of opportunity and research vessels of other countries. The MV *Atlantic Pursuit*, belonging to Clearwater Fine Foods, was used to initiate a clam dredging experiment.

The CCGS *Parizeau* and CCGS *Hudson* participated in the Swiss Air Flight 111 recovery operations off Peggy's Cove.

At the end of the year, the CCGS *Sigma-t* was retired.

1999

With the retirement of CCGS *Sigma-t*, the fleet was reduced to:

- CCGS *Hudson*
- CCGS *Parizeau*

- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. The CCGS *Teleost* from the Newfoundland Region was used in an otter trawling experiment. Field programs were conducted on Canadian Coast Guard vessels from other DFO regions, vessels of opportunity and research vessels of other countries.

The Canadian Coast Guard proposed to replace the CCGS *Hudson* with the CCGS *Sir William Alexander*, a high endurance multi-tasked light icebreaker, but this proposal was dropped after further study.

2000

Shortfalls in funding resulted in reduced vessel time at sea. Uncertainties made it challenging to plan national contributions to international programs and partnerships with universities or national/zonal initiatives.

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Parizeau*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. Field programs were conducted on Canadian Coast Guard vessels from other DFO regions, vessels of opportunity and research vessels of other countries.

The CCGS *Hudson* completed the first phase of an extensive refit to prolong its working life.

2001

The CCGS *Parizeau* was retired and transferred to Crown Assets for disposal. A few years later she was sold and renamed *Destiny Empress*. In 2009, the ship was seized in Spain and the crew arrested for drug smuggling. A large cache of cocaine with an estimated street value of £375 million was found in a secret compartment. In 2011, she was sold by Spanish authorities in auction and taken to Turkey for demolition.

With the retirement of CCS *Parizeau*, the fleet was reduced to:

- CCGS *Hudson*

- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. In addition, scientists conducted field programs on vessels of opportunity such as Coast Guard buoy tenders and icebreakers, commercial fishing and survey vessels and research vessels of other countries. Use was made of the Québec Region's CCGS *Martha L. Black*, equipped with the remote-operated vehicle ROPOS (Remotely Operated Platform for Oceanographic Science) to study deep-water corals. ROPOS was operated by the Canadian Scientific Submersible Facility in North Saanich, BC.

Two new 7.5 m survey launches were ordered, the first new boats for the Canadian Hydrographic Service in 15 years. They would provide trailerable vessels for use on small high priority surveys.

2002

The BIO fleet remained the same:
- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. Field programs were conducted on vessels of opportunity such as Coast Guard buoy tenders and icebreakers, commercial fishing and survey vessels and research vessels of other countries. The IB *Oden* from Sweden was used for a cruise to the Greenland Sea.
CCGS *Hudson* completed the final phase of the extensive refit to prolong its working life for another seven to ten years.

2003

The fleet remained the same:
- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Navicula*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys.

Field programs were conducted on vessels of opportunity such as Coast Guard buoy tenders and icebreakers, commercial fishing and survey vessels and research vessels of other countries.

The multibeam system on the CCGS *Matthew* was upgraded to improve the efficiency and quality of bathymetric surveys.

A fire in the engine room of the CCGS *Alfred Needler* caused extensive damage and she was removed from service for the rest of the year.

The sailing vessel *Sedna* visited from its home port of Cap-aux-Meules, QC. The 51 m, three-masted, steel-hulled sailing vessel was on a mission to produce a five episode National Film Board television series on the arctic and climate change for *The Nature of Things*.
At the end of the year, the CCGS *Navicula* was retired after 35 years of service.

2004

This was a difficult year for the aging and reduced research fleet and there was considerable loss of program activity due to breakdowns and the previous year's fire on the CCGS *Needler*. The need for modern, well-equipped and well-maintained research ships was an important challenge. The Canadian Coast Guard prepared a long-term plan for fleet renewal, including the scientific research and monitoring components.

With the retirement of the CCGS *Navicula*, the fleet was reduced to:

- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Alfred Needler*
- CCGS *J.L. Hart*

The Maritime Region's time on the CCGS *F.C.G. Creed* from the Quebec Region was utilized by the Canadian Hydrographic Service and Natural Resources Canada for multibeam surveys. Field programs were conducted on vessels of opportunity such as Coast Guard buoy tenders and icebreakers, commercial fishing and survey vessels and research vessels of other countries.

The CCGS *Matthew* ran aground at Cow Head, NL, and was out of service for the remainder of the season.

At the end of the year, the CCGS *J.L. Hart* was retired from service.

2005

Replacement of the ageing Science fleet continued to be a high priority. Two replacement research trawlers, one for each coast, were announced in the 2005 spring federal budget.

With the retirement of CCGS *J.L. Hart,* the fleet was reduced to:

- CCGS *Hudson*
- CCGS *Matthew*

- CCGS *Alfred Needler*

Field programs were conducted on Canadian Coast Guard vessels, vessels of opportunity, commercial fishing and survey ships and research vessels of other countries. A multibeam survey was conducted on the CFAV *Quest*, operated by the Royal Canadian Navy. The CCGS *Creed*, based in DFO Quebec Region, was used by both the Canadian Hydrographic Service and Natural Resources Canada for multibeam survey work. The IB *Oden* was used to carry out a transect across the Arctic Ocean.

2006

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Alfred Needler*

Field programs were conducted on Canadian Coast Guard vessels, vessels of opportunity and research vessels of other countries. The CCGS *Creed*, based in the DFO Quebec Region, was used by both the Canadian Hydrographic Service and Natural Resources Canada for multibeam survey work in the Gulf of St. Lawrence and Bay of Fundy. The CCGS *Wilfred Grenfell*, out of St. John's, NL, was used to evaluate the ability of the Department of National Defence's Deep Submergence Intervention System to work from a Canadian Coast Guard platform.

For the first time, ROPOS (Remotely Operated Platform for Oceanographic Science), operated by the Canadian Scientific Submersible Facility in North Saanich, BC, was deployed on CCGS *Hudson* and used to study seabed biodiversity in the Northeast Channel.

2007

Replacement of the ageing scientific research fleet continued to be a high priority. A Statement of Requirements was developed for the CCGS *Hudson* replacement.

The Government of Canada announced several new ship building projects for the Canadian Coast Guard which included replacements for the CCGS *Hudson* and CCGS *Alfred Needler*.

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Alfred Needler*

Field programs were conducted on Canadian Coast Guard vessels, vessels of opportunity and research vessels of other countries. The CCGS *Frederick G. Creed*, based in DFO Quebec Region, was used by both the Canadian Hydrographic Service and Natural Resources Canada for further multibeam surveys in the Gulf of St. Lawrence and Bay of Fundy.

ROPOS, the Remotely Operated Platform for Oceanographic Science, a 6,000 m-capable ROV, was installed on the CCGS *Hudson* for the second time and used to conduct benthic surveys at The Gully, the Stone Fence and areas off Newfoundland.
The CCGS *Alfred Needler* was out of service for her transitional life extension, an extended refit that upgraded the vessel's systems as well as added considerable oceanographic science capability in preparation for the planned reduction from three to two research trawlers on the east coast. The programs planned for the CCGS *Alfred Needler* were conducted instead by the CCGS *Wilfred Templeman* and the CCGS *Teleost* operated by the Newfoundland Region. The CCGS *Alfred Needler* was expected back in service next year.

2008

The plans for replacing the CCGS *Hudson* were moving ahead with completion of the Statement of Requirements expected in early 2009.
The fleet remained the same:

- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Alfred Needler*

Field programs were conducted on Canadian Coast Guard vessels, vessels of opportunity and research vessels of other countries. The CCGS *Frederick G. Creed*, based in the DFO Quebec Region, was used by both the Canadian Hydrographic Service and Natural Resources Canada for further multibeam surveys in the Gulf of St. Lawrence and Bay of Fundy.

2009

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Alfred Needler*

Field programs were conducted on Canadian Coast Guard vessels, vessels of opportunity and research vessels of other countries. The CCGS *Frederick G. Creed*, based in the DFO Quebec Region, was used by the Canadian Hydrographic Service and Natural Resources Canada for multibeam survey work in the Gulf of St. Lawrence. Researchers from the Canadian Hydrographic Service and Natural Resources Canada participated in surveys on the CCGS *Louis S. St-Laurent* in support of Canada's United Nations Convention on the Law of the Sea (UNCLOS) program. The Canadian Hydrographic Service also had a hydrographer aboard the Swedish icebreaker IB *Oden* that was conducting a joint Canada-Denmark UNCLOS survey over the Lomonosov Ridge. Scientists participated in the joint Canada-Spain program called NEREIDA aboard Spanish research vessels off the Flemish Cap to investigate the Northwest Atlantic Fisheries Organization (NAFO) fishing areas off Canada's east coast.

2010-2012

The fleet remained the same:

- CCGS *Hudson*
- CCGS *Matthew*
- CCGS *Alfred Needler*

These three remaining vessels were reaching the end of their expected lifetimes.

Field programs were conducted on Canadian Coast Guard vessels, vessels of opportunity and research vessels of other countries.

PROGRAM

This section provides representative examples of the broad range of research programs that have been carried out at BIO and illustrates how they evolved in response to scientific opportunities and changing government priorities. Some of the examples, especially in the early years, are quite general and cover mandates and plans. With time the entries become more specific and include some details such as geographic location, collaborators, methods and application of the results. This is not a complete account of all the research programs that have been conducted at BIO but it does identify some of the principal activities of the different government agencies that have been housed on the BIO campus over the years. More recent fisheries and environmental management programs are included. Technology highlights are not included but are presented in the following section. In selecting these examples, priority was given to large, multiyear team projects that often included collaboration with agencies outside BIO. More detail can be found in the BIO Annual and Biennial Reviews, the articles in *Voyage of Discovery* and other historical accounts listed in the References.

1962

BIO was designed to become Canada's centre for hydrography, oceanography, geophysics, chemistry and geology for Atlantic Canada and most of the Canadian Arctic. The two major activities at the outset were hydrography and oceanographic research, combined for the first time in one institute to strengthen both. A high level of electronic and mechanical design engineering support was planned from the start and modern digital computing and analysis facilities were acquired to handle the masses of data to be collected.

The main program in the first year consisted of projects previously initiated by the two principal founding agencies, the Canadian Hydrographic Service and the Atlantic Oceanographic Group. The Canadian Hydrographic Service program was directed from Ottawa but responsibility was expected to shift with time to BIO as regional staff were assembled. Hydrographic surveys were carried out at various locations in Atlantic Canada, Hudson Bay and the Arctic.

The Atlantic Oceanographic Group oceanography programs focused on the deep ocean circulation between Nova Scotia and the Azores, studies of energy exchange at the air-sea boundary, the heat budget of the Gulf of St. Lawrence and exploratory oceanographic surveys of Arctic waters using Department of Transport icebreakers.

Expansion of the existing program was planned and additional projects were initiated with the arrival of newly hired Marine Sciences Branch staff. The Oceanographic Services Laboratory was established and conducted salinity analyses in support of BIO projects. A project began to equip BIO for ice-borne Arctic operations. Submarine geology, marine geophysics and sea-ice physics programs were planned to begin in 1963, as well as a small theoretical group in physical oceanography. Plans were also made to expand the program in Arctic oceanography and include radiochemistry in the chemistry program.

From the very beginning, a program of seasonal student employment was created to introduce selected students to the work of BIO, provide assistance to permanent staff during the busy summer season and evaluate potential permanent staff.

A long-term program was established to understand the circulation and variability of the northwest Atlantic Ocean. The research was organized around the three interconnected themes of observation, development of formulae that govern major processes and development of predictive numerical models.

The geological program followed six approaches as it developed over the years: detailed geological mapping in specific areas, reconnaissance surveys on a regional basis, studies of seafloor processes, development of scientific concepts, technological development and archiving data and samples collected at great expense.

1963

The BIO program evolved rapidly to meet national requirements in support of fisheries, navigation, maritime defence, natural resources and weather forecasting.

Current Surveys and additional hydrographic staff arrived from Ottawa.

Geologists carried out research as part of the Polar Continental Shelf Project.

The CCGS *Labrador* and CSS *Baffin* undertook the first marine geophysical surveys in Baffin Bay and Nares Strait.

The Theoretical Oceanography, Marine Geophysics and Engineering Services groups were established.

The Oceanographic Services Laboratory expanded to include the analysis of oxygen, nutrients, pH and alkalinity as well as the processing of bathythermograph (BT) slides.

The Atlantic Oceanographic Group continued to focus on the physics, chemistry, geology and biology of waters in Atlantic Canada with a view of understanding and increasing important marine food resources. The program was slanted towards problems concerning groundfish and other bottom-oriented fisheries but physical and chemical studies also had bearing on problems associated with the movements and distribution of fish eggs and larvae.

Two oceanographic cruises were carried out in the Arctic, one in collaboration with the International Commission of Northwest Atlantic Fisheries (ICNAF).

Studies of the ocean waters off the east coast of Canada continued with a two-ship cruise off the Tail of the Banks.

Studies of the circulation dynamics and driving forces in the Gulf of St. Lawrence continued with field studies concentrated in the Pont-des-Monts area and the Strait of Belle Isle.

The Halifax Section, established in 1950, continued to be sampled when possible. Recent observations, together with those taken previous years, were analyzed to establish seasonal patterns of temperature, salinity and density.

Oceanographic data collected by BIO were submitted to the Canadian Oceanographic Data Centre for logging and processing that in turn provided interpolated data of temperature, salinity, oxygen, Sigma-t, sound velocity, dynamic height, specific volume anomaly and potential energy anomaly.

A study of the chemical composition of sediments in the Gulf of St. Lawrence was initiated. Studies were also underway on the composition and production of benthic communities in the southwestern part of the Gulf in collaboration with the St. Andrews Biological Station.

The new radiochemistry program began to investigate the concentrations of fallout fission products in the ocean for purposes of studying their transport and the mixing rates of the oceans.

The first multidisciplinary teams were assembled to study complex ecosystems such as bays and estuaries. One investigated the cause of oyster deterioration at Ellerslie, PEI, while another evaluated the environmental processes at Point Belledune, an industrial area in northern New Brunswick.

The Oceanographic Services for Defence, manned by BIO staff located at HMC Dockyard in Halifax, produced charts of surface temperature three times a week that were transmitted to naval vessels by radio facsimile.

1964

The various programs at BIO were now firmly established and results were beginning to be achieved. The pace of hydrographic surveying was maintained and program control gradually transferred from Ottawa to BIO.

The first multidisciplinary offshore joint hydrographic/geophysical survey was successfully undertaken using the CSS *Baffin* in the Bay of Fundy. The feasibility of such operations was proven and they were anticipated to be even more successful in the future as field staff became more familiar with the operations of other groups. This practice of joint surveys continued for at least two decades to cover the continental margin off eastern Canada and were augmented in later years by surveys conducted by the hydrocarbon exploration industry.

Geophysical surveys were carried out on the continental shelf off Nova Scotia, in the Bay of Fundy and in the Canadian Arctic.

The CSS *Hudson* conducted a geophysical survey of the continental shelf that resulted in the discovery of the Orpheus Anomaly, a Triassic graben structure indicating thick sequences of sediments east of Cape Breton Island.

Geologists established the journal *Maritime Sediments* (now the e-journal *Atlantic Geology*) that was published by the Atlantic Geoscience Society.

The first sedimentological map of Hudson Bay, based in part on BIO research, was published.

Marine geology projects were carried out in the Arctic Ocean, Arctic Islands, Nares Strait, Baffin Bay, Atlantic Ocean, Scotian Shelf, Gulf of St. Lawrence, Northumberland Strait and numerous bays and inlets of Atlantic Canada. These activities involved studies of seafloor sediments and associated fauna, submarine topography, geological formations and structures and stratigraphy of unconsolidated sediment layers, some of which were designed for comparison with Arctic seabed environments.

The air-sea interaction program tested new equipment and techniques on a CSS *Baffin* cruise off Aruba in collaboration with the Woods Hole Oceanographic Institution.

Experiments in deploying deep-sea moorings and acquiring current data were carried out.
A quantitative study of the temperature and salinity characteristics of the Gulf of St. Lawrence in both summer and winter was completed.

Work continued on the development of numerical models of ocean circulation.

The three-year program collecting temperature, salinity, dissolved oxygen and silicate data in the deep water between the east coast of Canada and the Azores was completed. In addition, deep-water samples were collected for the analysis of radioactive fission products (e.g. cesium and strontium).

The Atlantic Oceanographic Group continued to expand its programs in physical, geological, chemical and biological oceanography in order to better understand the fundamental links between the environment and fisheries.

The study of the circulation, dynamics and driving forces in the Gulf of St. Lawrence continued, as were geological investigations of the Magdalen Shallows. The analysis of benthic fauna samples collected previously on the Magdalen Shallows was completed and attempt made to relate the benthic organisms to the stomach contents of cod caught at the same time. A new program in plankton ecology was initiated.

1965

The BIO program now included tides and currents, hydrographic charting, marine geophysics, marine geology, physical oceanography, air/sea and air/sea/ice interactions, chemical oceanography and biological oceanography. In support of all of these activities was a program of instrument research and development. This broad approach within one organization justified the provision of large modern facilities, notably ships, and encouraged among the staff the interdisciplinary exchanges of ideas and experience which were essential to the effective study of the ocean. The many projects arranged themselves naturally into a spectrum extending from the interface between the atmosphere and sea, through the water mass itself, to the sea floor and the earth beneath.

Hydrographic surveys were conducted at various locations around Atlantic Canada. A major tidal current survey was conducted in the Bay of Fundy. Regular maintenance of the 15 permanent tide gauges in Atlantic Canada, Hudson Bay and the Arctic continued and four additional tide gauges were added to the network.

The CSS *Hudson* carried out various surveys for hydrography, geophysics and geology in Hudson Bay, Gulf of St. Lawrence, and over the Orpheus gravity anomaly east of Cape Breton Island.

Marine geology studies were carried out in the Arctic Ocean, Hudson Bay, the inshore waters of the Atlantic Provinces and the adjacent continental shelf.

The CCGS *Labrador* conducted the first systematic geological survey of the Labrador Sea which demonstrated that sedimentary rocks underlie the central and outer shelf.

The CSS *Hudson* undertook a geophysical survey of the Mid-Atlantic Ridge which made it possible to compile maps of bathymetry, total field magnetic anomaly and gravity anomaly which covered an area about 50 x 20 miles along the crest of the Ridge.

Major physical oceanographic studies were carried out on the nature of the Gulf Stream south of the Grand Banks and on the formation and subsequent spreading of deep water in the Labrador Sea in winter.

A major oceanographic and current survey was carried out in the St. Lawrence Estuary to learn more about its circulation. A major innovation in oceanographic sampling technique was employed. Strings of water bottles were anchored across a section and tripped simultaneously by clockwork devices that dropped messengers at a pre-set time.

Further advances were made in the development of numerical models of ocean circulation, in particular improving equations governing thermohaline circulation.

As part of the Oceanographic Services for Defence program, daily charts of sea surface temperature and layer depth were prepared over an area from the tip of Greenland south to Bermuda

Water samples for fission product analysis were collected in Baffin Bay, the Labrador Sea and the North Atlantic. The results helped interpret the radioactivity levels of fallout fission products from atmospheric bomb testing. A naval mortar, cast in 1878 and weighing 11 tons, was placed just outside the laboratory window and used as radiation shield for sample analysis.

The first comprehensive investigations of modern Foraminifera populations inhabiting eastern Canadian continental shelf environments were begun.

Biological oceanographic studies continued to develop and focused on describing the structure of biological communities and the rates of energy transfer between different trophic levels.

Plans were underway for expanded field studies in the Gulf of St. Lawrence in collaboration with other marine research institutes to provide a broad understanding of the Gulf as a system. It was also proposed to begin an ecosystem study of nearby St. Margaret's Bay that was thought large and deep enough to serve as a microcosm representative of larger marine ecosystems. The St. Margaret's Bay study became a component of the International Biological Program (IBP), an international program of biological studies focused on the productivity of biological resources in different types of ecosystems and their response to environmental change.

1966

The BIO research program continued to develop under the aegis of the Canadian Committee on Oceanography (CCO) as part of the national oceanographic research program. The CCO, on which eight agencies of the federal government and four universities were represented, was the central coordinating and policy recommending body for Canadian oceanography.

Considerable attention was devoted to fostering associations with universities, especially Dalhousie, and other research establishments. It was felt strongly that encouragement of graduate research and assistance in graduate training was a BIO responsibility as well as an opportunity to maintain contact with the stimulating university environment. Ship time was made available to universities without charge but this policy had to be terminated in the 1980s due to funding pressures.

Hydrographers were engaged in charting and tidal projects extending from the Arctic Archipelago to Nova Scotia. A major undertaking was a detailed charting of the Grand Banks. The key to this successful survey was the deployment of a long-range system of position-fixing which provided a position accuracy of approximately 700 feet out to the edge of the bank.

Further geophysical surveys of the Mid-Atlantic Ridge were conducted by CSS *Hudson*. A technique was developed for producing on-the-spot bathymetric, magnetic and gravitational maps which were used to determine the most interesting places to sample the bottom by coring, photography and dredging. This technique was made possible by GEODAL, the BIO data logging and processing system.

Seismic studies of subsurface bedrock were continued in Gulf of St. Lawrence using CNAV *Sackville* and a charter vessel.

The continuing program of marine geological investigation of the continental shelf encompassed a wide variety of projects. Fieldwork extended from the Arctic to the Bay of Fundy. Progress was made in delineating the sedimentary structures underlying the Scotian Shelf.

An atlas and report was completed which presented a new concept of major water mass transport in the region between the Grand Banks and the Azores.

An intensive study on the growth of polar sea ice continued in Cambridge Bay, NWT, and provided quantitative information about the dynamics of the streamers of salt-rich water that flowed downwards from the ice/sea water interface.

Up to now, temperature and salinity data had been obtained at discrete depths using bottle casts. However, the first continuous recording salinity-temperature-depth (STD) meter was used to obtain vertical profiles of these variables.

Surveys were undertaken in the Cabot Strait and Strait of Belle Isle to obtain a better understanding of the interchange of water masses between offshore waters and Gulf of St. Lawrence.

In response to a request from the Department of Public Works, a study was carried out in Petit Passage, NS, to provide current information to support feasibility studies of a proposed causeway between Digby Neck and Long Island.

The CSS *Hudson* initiated studies of the physical and chemical oceanography of the Irminger Sea south of Greenland. The first systematic observations of seabirds were made on this cruise.

The CSS *Hudson* conducted 143 oceanographic stations on a cruise to the Labrador Sea that provided a good start on tackling the challenging problem of determining the mechanism of formation and the rate of production of North Atlantic deep waters.

Geochemical studies of marine sediments and a benthic sampling program were conducted in the Gulf of St. Lawrence.

A multidisciplinary ecosystem research program was initiated in nearby St. Margaret's Bay in order to investigate production dynamics in a coastal system that could be used as a model for understanding larger marine ecosystems of interest. Initial projects included determining phytoplankton primary production, the first such measurements made at BIO, a quantitative benthic sampling program and initial studies on the distribution and abundance of fish.

1967

Personnel on the CSS *Hudson* studied the formation of deep Atlantic water in the Denmark Strait in cooperation with the National Institute of Oceanography and the Woods Hole Oceanographic Institution. The ship's endurance was rigorously tested with heavy sea ice, icing of the ship's superstructure, extreme wind and wave conditions and low air temperature but the program was completed successfully.

CSS *Hudson* supported offshore dredging and sampling of bedrock and surficial sediments on the San Pablo Seamount south of Nova Scotia and Flemish Cap east of Newfoundland.

Geologists demonstrated that acoustic reflection data collected by echo sounders could be used to determine the nature of sedimentary units and their stratigraphic relationships on the continental shelf. This subsequently led to the development of a multiyear program to map continental shelf sediments off Atlantic Canada, starting with the Scotian Shelf.

1968

Increased effort was devoted to applied research projects undertaken to solve specific problems raised by government agencies or industry. For example, the effects of the construction of a causeway and large pulp mill were investigated in Pictou Harbour. Studies were also carried out in the Strait of Canso area where the construction of a causeway, pulp mill, oil refinery, heavy water plant and a thermal powered electrical generating station had raised concerns about water pollution.

Hydrographic surveys were conducted on the Grand Banks, Gulf of St. Lawrence and along the east coast of Baffin Island.

Further progress was made in the integration of hydrographic and geophysical surveys to obtain the economies of operation resulting from one ship performing both functions simultaneously. The CSS B*affin* was outfitted with a gravity meter, towed magnetometer and data processing systems and carried out a joint hydrographic and geophysical survey on the Grand Banks.

A *CSS Hudson* expedition to the Caribbean Sea carried out hydrographic, geological and biological surveys on behalf of the Federation of Caribbean States.

An immense amount of geophysical data was collected in field efforts centered on the Gulf of St. Lawrence, the Grand Banks and the Flemish Cap as a part of the on-going program of geophysical exploration and mapping of the continental shelf and margin of eastern Canada.

Over the previous few years, reconnaissance investigations of marine geology using techniques of physical geology, micropaleontology and geochemistry ranged far and wide over Atlantic Canada. Emphasis was now given to more intensive investigations of the Scotian Shelf and Grand Banks.

The submersible *Pisces 1* was deployed from the CCGS *Labrador* to carry out geological research in the Arctic Archipelago.

A cruise to the Mid-Atlantic Ridge recovered basalt and other rock samples. Fission track dating gave results consistent with the hypothesis of sea floor spreading.

While physical oceanographers continued to work on understanding currents in the Gulf of St. Lawrence and the formation of deep water in the North Atlantic, an increasing amount of attention was being given to understanding the problem of variability in the ocean. This was approached by a combination of theoretical and numerical model studies, laboratory experiments and observations at sea using moored buoy systems.

With the transfer of the responsibility of managing the Ellerslie field station to BIO, studies were initiated on shellfish production in shallow coastal systems.

Studies continued to investigate the biomass and production rates of important components of the St. Margaret's Bay ecosystem system. The importance of spatial and temporal distributions of plants and animals, both pelagic and benthic, on rates of production became better recognized.

Studies were initiated on the zonation, biomass and growth rate of seaweeds. Physical oceanographic studies provided environmental information on the basic processes underlying marine production.

1969

The Honourable J. J. Greene, Minister of the Department of Energy, Mines, and Resources, announced in the House of Commons the forthcoming Hudson 70 Expedition, a year-long cruise of CSS *Hudson* around North and South America.

Seismic studies of sediment and bedrock were continued in Gulf of St. Lawrence and Strait of Belle Isle using CNAV *Sackville* and MV *Fairmore*.

A long-term program was initiated to develop numerical tidal models of the Bay of Fundy, Gulf of Maine and George's Bank system that could be used to examine the potential environmental impacts of tidal power development in the upper reaches of the Bay of Fundy. It was discovered that this region was a single ocean system with a natural resonant period slightly longer than the M_2 semidiurnal period (12.42 h) that was responsible for the exceptionally large tides in the Bay of Fundy.

A multidisciplinary research program was initiated in Bedford Basin and Halifax Harbour to investigate the impacts of untreated sewage discharges on ecosystem health and to compare the properties of this system to those in nearby St. Margaret's Bay.

Studies were begun to examine the effects of Langmuir circulation on the distribution of organic particles in oceanic waters off Bermuda.

On short notice, an environmental research program was initiated to investigate the impacts of an accidental discharge of elemental phosphorus that caused extensive fish kills in Long Harbour and Placentia Bay, NL.

1970

As part of a national trend, BIO programs began to give increasing emphasis to environment quality and pollution studies.

A navigation group was established to provide BIO surveyors and scientists with the best possible positioning systems for investigations at sea.

The first current meter moorings were deployed in the Drake Passage during the Hudson 70 Expedition.

The possibility of the use of specially designed supertankers in Arctic waters, such as the SS *Manhattan* that successfully traversed the Northwest Passage in 1969, and the pollution threat they presented to the delicate polar ecology led to increased hydrographic charting in the Beaufort Sea and Northwest Passage. The CSS *Baffin* conducted a joint hydrographic/geophysical survey in the Beaufort Sea and discovered large pingo-like features on the sea floor which posed a distinct hazard to navigation.

Using sidescan sonar, ice scouring on the sea floor caused by sea ice was discovered in the Beaufort Sea during the Hudson 70 Expedition.

A new program was established to conduct stratigraphic mapping of the continental shelf.

A map of surficial sediments on the Scotian Shelf was published, the first in a series of surficial sediment maps for the Canadian continental shelf. These maps, based on sedimentary formation identification and their age (i.e. preglacial bedrock, glacial till, postglacial mud, silt, sand,) were the first of their kind in the world. They were of value to fishermen, oil companies, mining engineers, cable companies and other scientists.

Scuba-diving geologists sampled bedrock outcrops on the floor of St. George's Bay, NS.

Pockmarks, features in sediments caused by escaping gas, were discovered and described on the Scotian Shelf. This was the first time these unique seabed features had been found anywhere in the world.

With increasing demand for measurement of basic oceanographic properties such as salinity, chloride, nitrate, nitrite, phosphate, silicate and dissolved oxygen, attention was given to the automation of laboratory analytical procedures and development of *in situ* measurement devices.

Studies began to investigate the effects of hydropower development and water diversions on freshwater discharge into the St. Lawrence Estuary. There was concern that altering the patterns of seasonal outflow could lead to major changes in the mixing and flushing properties that give estuaries their high level of biological productivity.

BIO assisted the Department of Transport and Imperial Oil Ltd. in the cleanup effort of the MV *Arrow* oil spill in Chedabucto Bay. Dr. William L. Ford was seconded as Scientific Coordinator of the Operation Oil Task Force. Numerous short-term scientific investigations were conducted to investigate the behaviour and effects of Bunker C fuel oil in cold-water environments.

The Hudson 70 Expedition provided a unique opportunity for testing hypotheses about production rates by comparing conditions over a variety of temperate and tropical water masses in both the Atlantic and Pacific Oceans. Observations of particle size distributions using the Coulter Counter showed near constant biomass over all size categories from bacteria to whales and led to the development of the biomass spectrum theory which was later developed further and applied by several subsequent projects.

A long-term research program was initiated to investigate the distribution, behaviour, fate and ecological effects of contaminants in marine ecosystems with an initial focus on petroleum and chlorinated hydrocarbons.

1971

A major geophysical survey was undertaken in Baffin Bay and Davis Strait to study the variations in crustal structure, map the ocean-continental boundary and study the major features on the surrounding continental shelves.

A map of sediments in the Gulf of St. Lawrence was published which revealed that sediment distribution was controlled by various elements of submarine morphology.

A team of BIO scientists visited Bermuda to advise its government on how to deal with the tar washing up on its beaches that originated from oil tankers cleaning their tanks at sea and was harming the tourist industry.

The Halifax-Bermuda Section program was initiated which conducted quarterly cruises for two years to study marine pollution and a wide variety of physical, chemical and biological variables in the water column on the Scotian Shelf and in Slope Water, the Gulf Stream and the Sargasso Sea. The Scotian Shelf portion followed the Halifax Section established earlier. Numerous BIO and Dalhousie staff participated.

The newly created Environmental Protection Service laboratory began a long-term program to develop bioassay testing procedures and toxicity regulations for industrial effluents under the Fisheries Act.

1972

Hydrographic surveys in the Arctic continued to make use of Department of Transport icebreakers. A multidisciplinary hydrographic and geophysical survey was conducted in the Labrador Sea using the CSS *Hudson*.

A hydrographic survey of James Bay was carried out to obtain baseline data for evaluating expected changes in river flow conditions resulting from hydroelectric development projects proposed by Hydro-Québec.

With the establishment of the Basin Analysis Group, a new project was initiated with the objective of assessing the potential of oil and gas resources in eastern Canada sedimentary basins.

Work continued on investigating the interaction of internal waves with bottom topography.

A new study of oceanic microstructure was started with the aims of parameterizing it and examining its relation to larger scale phenomena. The new oceanic turbulence probe was tested under different conditions during a cruise to the Gulf Stream.

A new project was started to document the wave climate along the Atlantic coast to provide information on the seasonal occurrence and distribution of extreme wave heights that could be used to improve the design of offshore structures needed by the developing oil and gas industry.

The CSS *Hudson* participated in a multi-national study of the Gulf Stream off the Tail of the Grand Bank in collaboration with the RV *Chain* of the Woods Hole Oceanographic Institution and the RV *Cirolana* from Lowestoft, UK. The newly developed ability to deploy current meters in the Gulf Stream played a major role in the success of this study.

A study of the LaHave Estuary was initiated, the first estuarine system studied by BIO. Results were compiled into a complete geochemical description that could be used to understand the significant processes which controlled the geochemical role of estuaries.

Extensive chemical studies of the Gulf of St. Lawrence were carried out to examine the impacts on both the water column and sediments of the large amounts of industrial and municipal wastes received from the eastern USA and Canada. Properties measured included major and trace elements, oxygen and organic carbon and nitrogen.

A new program using stable isotopes of carbon, oxygen and hydrogen was initiated to study a variety of oceanographic problems. The first study focussed on examining the stable carbon isotope ratios of dissolved and particulate organic matter, plankton and sediments in Bedford Basin.

Studies were initiated to determine the effects of the St. Lawrence River discharge on fisheries production in the Gulf of St. Lawrence, Scotian Shelf and Gulf of Maine.

Extensive surveys were carried out to determine the concentration and distribution of petroleum and natural hydrocarbon in seawater and sediments in wide variety of areas ranging from coastal inlets to the Sargasso Sea.

The factors governing the transfer and accumulation of pesticides and related contaminants were investigated with the objective of developing predictive numerical models of contaminant behaviour in natural systems.

A long-term program was initiated to investigate organochlorine contaminants (DDT, PCBs, etc.) in marine mammals including beluga whales, harp seals, ringed seals, grey seals and harbour seals.

A program was begun to study exchanges between pelagic and benthic components of marine ecosystems. Organic matter was measured in sedimenting detritus and surface sediment in Bedford Basin to quantify the pathways of decomposition of organic matter in the water column.

Plans were developed for a major ecosystem research project in the Gulf of St. Lawrence.

Comparative studies of coastal inlets were expanded to include Petpeswick Inlet where new field studies investigated the contributions of salt marshes and eelgrass to system productivity.

In collaboration with the Cape Breton Development Corporation, steps were taken in setting up commercial scale aquaculture systems for oyster, mussels, Irish moss and salmon.

A survey of mackerel eggs and larvae was carried out in the southern Gulf of St. Lawrence using the MV *Harengus* and the CNAV *Sackville*.

A new program investigating marine mammal energetics was launched.

The new biomass spectrum theory was applied to predict the population density of monsters in Loch Ness from fisheries data and the results published in a reputable scientific journal.

1973

Staff assisted the Department of National Defence in the recovery of a Sea King helicopter that had crashed and sank approximately 50 km offshore from Halifax.

Staff were involved in examining the condition of the sunken barge *Irving Whale* that was located in 60 km north of Prince Edward Island and still contained 4500 tons of Bunker C fuel oil.

Geological studies were begun to obtain the information needed to assess the potential effects of tidal power development on sedimentological processes in the upper reaches of the Bay of Fundy.

Using existing data, geophysicists developed attributes and concepts for the geology of Laurentian Channel and south of Newfoundland, differences between the southern Grand Banks continental margin and that of the Scotian Shelf, the offshore Magnetic Quiet Zone and the deep structure of Baffin Bay and its margins. Criteria were prepared for contract production of 1:250,000 scale Natural Resource Charts showing magnetic and gravity field values based on BIO data.

Beginning with the LaHave River and Estuary, geochemists began constructing models of geochemical fluxes between river-estuarine systems and coastal environments.   Methods of analysis were improved for determining suspended particulate matter and trace elements in seawater.

Geoscientists, studying regional subsurface geology, described two major depocentres, the Scotian Basin and the East Newfoundland Basin, based on industry well data and seismic profiles. The rock units and major depositional systems of the Scotian Basin were outlined further from lithostratigraphic, biostratigraphic and sedimentological studies of well samples.

The hydrocarbon potential of offshore sedimentary basins was evaluated by geochemical analysis of offshore well cuttings collected by industry.

Micropaleontologists continued assessment of foraminiferal distribution and ecology in arctic, maritime and mid-ocean environments.

The CSS *Hudson* participated in Overflow '73, an international physical oceanographic program sponsored by the International Council for the Exploration of the Sea, to measure water transport in the Denmark Strait. The program involved 12 ships from six countries. Current meters were deployed using improved BIO mooring technology. OCTUPROBE was used to observe microstructure.

Scientists participated in the Joint North Sea Wave Project held in the German Bight to study how waves dissipate and the extent of the wind energy in wave fields.

A major multidisciplinary study was initiated in the Strait of Canso and Chedabucto Bay to determine the impacts of local industrial development on the marine environment.

The St. George's Bay larval fish program began that gradually expanded into a long-term multidisciplinary study of the entire ecosystem involving many BIO scientists.

Using new equipment designed at BIO, water temperature and fluorescence were measured simultaneously for the first time from a moving ship to provide exciting new information on the spatial complexity of marine phytoplankton in the St. Lawrence Estuary.

A program was initiated to investigate the effectiveness and toxicity of commercially available oil spill dispersants and to identify products acceptable for use in Canadian waters. In time, this research led to the development of oil dispersant use guidelines for Canada.

1974

An in-depth Make-or-Buy analysis was carried out for the entire Institute and a number of projects with a potential for contracting out were identified. It was anticipated that a substantial portion of the BIO program could be achieved in close cooperation with Canadian industry.

The involvement of BIO staff in international affairs was increasing. With the establishment of the Law of the Sea under the UN, it was becoming increasingly evident that oceanographers would have to conduct their work under new international regimes. These would be more restrictive than the traditional freedom of the seas but should encourage international cooperation.

The CSS *Baffin* undertook a hydrographic production/training survey cruise off Guyana, South America.

Staff provided advice during the clean-up operation of an oil spill at Saglek, Labrador.

A CSS *Hudson* cruise supported a geophysical study of Labrador Sea and Baffin Bay plus geological sampling in Barrow Strait to assess conditions for a possible gas pipeline crossing.

Continued hydrographic and geophysical surveying provided sufficient data for initial recognition of magnetic lineations in Labrador Sea. The submarine geomorphology of Flemish Cap and Pass was described using data from previous surveys.

Geophysicists suggested that Labrador Sea and Baffin Bay continental margins exhibit properties similar to those of the rifted margin off Nova Scotia. Geophysicists also improved methods to determine diurnal magnetic variations to correct offshore magnetic field measurements.

Understanding the zonation of the sedimentary basins off Nova Scotia and Newfoundland was advanced through studies of foraminifera, ostracoda, and palynomorphs. Sample cuttings and cores from industry wells and seismic profiles were used to increase resolution of the younger Tertiary rocks on the Scotian Shelf. Organic geochemists continued assessment of oil and gas potential in well cuttings. Studies were initiated of the effects of organic matter on the engineering properties of marine sediments that are foundation material for offshore structures.

Micropaleontologists defined foraminiferal biotopes in modern sediments of Chaleur Bay, NB, foraminiferal and molluscan distribution in the Beaufort Sea and down-core changes in foraminiferal assemblages in the Northwest Passage and Labrador Shelf.

The Strait of Canso program was initiated to investigate the environmental impacts of the Canso Causeway (built in 1956) and recent industrial development that included a pulp and paper mill, a heavy water plant, an oil refinery, a gypsum washing plant and an electrical power generating station fuelled by oil. In addition, the lingering effects of oil residues from the 1970 *Arrow* spill were studied in downstream Chedabucto Bay.

Coastal geoscientists documented coastline changes in the southern Gulf of St. Lawrence, ice in the littoral zone of northeast New Brunswick and bedform mobility in Cobequid Bay at the head of Bay of Fundy.

CSS *Hudson* and CNAV *Sackville* supported the final year of near-surface bedrock and surficial geology studies on the Cape Breton Shelf, Laurentian Channel and the western Grand Banks of Newfoundland. Interpretation of magnetic and gravity geophysical data showed connections with Newfoundland Appalachian trends and suggested the eastern edge of the proto-Atlantic before its mid-Paleozoic closing.

Scientists participated in the planning and operation of the oceanographic program of the Atlantic Tropical Experiment that was organized under the Global Atmosphere Research Program. This experiment, involving 30 ships, was carried out over the tropical Atlantic with the objective of studying atmospheric convection over tropical waters from June to September. The Canadian program was carried out from the Victoria-based weather ship CCGS *Quadra*.

An intensive two-year study of the circulation and mixing in the Bras d'Or Lakes was initiated to provide physical oceanographic information for aquaculture development investigations being conducted by the Cape Breton Development Corporation.

For the first time, the spatial distribution of phytoplankton on the Scotian Shelf was unambiguously observed using Batfish mounted with a CTD and fluorometer. In addition to this field program, theoretical investigations were undertaken to establish the critical scales of patchiness under different physical and biological conditions.

High frequency sonar was used to locate high concentrations of euphausiids (krill) in the Gulf of St. Lawrence.

The acoustic fish counting system was developed further and combined automatic processing of echo returns with data analysis to provide estimates of the numbers and sizes of different fish. Montreal Engineering Company was contracted to conduct an extensive survey of groundfish stocks on the Scotian Shelf using this new system. This system was the forerunner of the successful ECOLOG system.

Studies of discharge records of the St. Lawrence River and yearly catch of several commercial species in the Gulf of St. Lawrence indicated that freshwater influx into the Gulf was well correlated with the annual catches if river discharge is lagged for a period of years appropriate to the age of the species at commercial size. Further investigations of environmental factors southward along the Nova Scotia coast pointed to effects probably originating in the Gulf of St. Lawrence as important influences in the local oceanographic climate as far south as the Gulf of Maine. This project was among the first in the world to demonstrate the influence of environmental factors on fish production.

1975

The Navigation Group started the development of a computer-based system named BIONAV to integrate position information from multiple systems to improve offshore positioning. This information included Satnav (the US Navy Navigation Satellite System), ship's log and gyro and radio aids such as Loran-C and Decca. With time, information on ship's motion, wind and weather were also incorporated. All this information was combined statistically using error models based on observations of each subsystem.

A two-volume compendium of geoscience research entitled *Offshore Geology of Eastern Canada* was published summarizing the knowledge of geology and geophysics off eastern Canada.

A three-year multidisciplinary geoscience study of the Miramichi Estuary was initiated to explore the impact of the forest industry on the quality of the river and estuary.

Calibration of satellite imagery was initiated to evaluate suspended sediment concentrations in Minas Basin, and observations of sediment dynamics near the Windsor causeway continued.

Environmental geologists reported on the coastal dynamics of the Magdalen Islands in Gulf of St. Lawrence, foraminiferida and mollusca distribution in Chaleur Bay and eastern Canada, tidally-forced sediment dynamics in the Avon and neighbouring estuaries in the Minas Basin, hydrocarbon gases in modern shelf and nearshore basins and glacial features on Hamilton Bank, Labrador Shelf.

Geologists initiated participation in the international Deep Sea Drilling Program that, using the drill ship *Glomar Challenger*, over its fifteen-year life span provided crucial data to support the hypothesis of seafloor spreading and helped to prove the theory of plate tectonics.

Deep-sea sediment sampling and seabed photography of the Canada Abyssal Plain in the western Arctic Ocean were successfully achieved from a portable ice camp at the Arctic Ice Dynamics Joint Experiment site.

Petroleum geologists compiled oil well geochemical data to evaluate the possibility of biodegraded oil in the Jeanne d'Arc Basin beneath northeastern Grand Bank that was the location of the Hibernia oil discovery four years later.

Staff aided the Woods Hole Oceanographic Institution in the USA-USSR Polymode Experiment by laying deep-sea current meter moorings in the Gulf Stream.

The CSS *Dawson* returned safely after a trip into the Bermuda Triangle to study the fine-scale distribution of non-living particulate organic matter in seawater.

The Regional Ocean Dumping Advisory Committee was created to review ocean dumping applications required under the new Ocean Dumping Act.

The development of bioassay methodology expanded to include tests for measuring the toxicity of contaminated sediments.

The *Atlas of Eastern Canadian Seabirds* was published that reported the results of quantitative surveys of the breeding and pelagic distribution of seabirds north of 40°N and west of 40°W. Most of the data were collected on an opportunity basis on BIO vessels.

1976

Because the oil and gas industry and fisheries managers needed more information on the oceanography of the continental shelf, new programs were developed to study processes on the Scotian Shelf and Labrador Shelf. To accommodate this shift of focus, the deep sea physical oceanographic program and the chemical program in the Gulf of St. Lawrence were reduced.

BIO staff became increasingly involved in advisory activities as members of task teams, groups of experts and advisory boards associated with industry, universities, government and international organizations. They also became more involved in reviewing environmental impact assessments prepared by other parties.

New tide gauges were installed to collect tidal data for the calibration of numerical tidal models being developed to examine the potential impacts of tidal power development on the Bay of Fundy/Gulf of Maine system.

The first hydrocarbon potential assessment was completed for the Scotian Shelf, Grand Banks and Labrador Shelf.

A bedrock map of the eastern Canadian offshore was published, the first such map of this type in the world.

Using CSS *Hudson*, bedrock and geophysical mapping was conducted on the Baffin Island Shelf south of Cape Dyer. CSS *Hudson* also supported surficial geological sampling in Lancaster Sound.

Geophysical surveys and shallow bedrock drilling led to preliminary geological maps of rock units in northeastern Gulf of St. Lawrence, the inner northeastern Newfoundland Shelf and the southeastern Labrador Shelf. In subsequent years the data allowed recognition of five surficial seismostratigraphic units on the northeast Newfoundland Shelf.

Using CSS *Hudson*, bedrock and geophysical mapping was conducted on the Baffin Island Shelf south of Cape Dyer.

The Foraminifera program expanded to include studies that applied the results to paleoceanography, paleoclimatology, environmental monitoring and mapping.

Geologists began a multiyear regional study of the stratigraphy, age and composition of offshore surficial sediments on the shelves to better assess hazards posed by seafloor processes and geology for hydrocarbon exploratory drilling activities.

Radioactive sand was used for the first time to track sediment transport in the intertidal zone of Minas Basin. Radiocarbon dating of vibracores suggested that the present large tidal range in the Basin had only developed in the last 5,000 years.

An investigation was conducted of deep convection events taking place in the Labrador Sea at the end of the late winter cooling season.

The first measurements of carbon dioxide flux between the sea and atmosphere were made at Sable Island.

The Shelf Break Dynamics Program began on the edge of the Scotian Shelf south of Halifax in order to better understand a zone of high nutrient concentrations and biological activity. A large array of current meter moorings was deployed and revealed the importance and dynamics of the wind and Gulf Stream eddies on the flow at the shelf break.

Due to the continued interest by the offshore industry and government agencies, further studies were conducted on the wave climate along the Atlantic coast. Maximum wave conditions on the Labrador Shelf were found to be similar to the Scotian Shelf.

Work on numerical modelling of oceanic processes continued to expand with new staff and larger and faster computers. Initial focus was on the Labrador Sea with the goal of perfecting a realistic stratified model for use in conjunction with the observational program.

Chemists participated in three international intercalibration experiments aimed at ensuring the validity and comparability of trace metal data from marine science institutions around the world. Support was also given to the development of a marine standards program under the National Research Council.

The results from a four-year study of floating particulate petroleum residues in the North Atlantic indicated that they were virtually non-existent north of the Gulf Stream but were found in greatest concentration in the Sargasso Sea. This distribution reflected inputs from tankers and surface circulation.

The St. George's Bay larval fish study was expanded to include a mooring and hydrographic program, to determine the mean circulation, and additional biological studies.

Studies continued to document the recovery of Chedabucto Bay from the 1970 *Arrow* oil spill. It was discovered that weathered oil still remained in the intertidal sediments, especially in low energy environments such as salt marshes, lagoons and estuaries.

Theoretical work continued on predicting the responses of fish production systems to stressors with emphasis on the community level of response to fishery exploitation.

The five-year Eastern Arctic Marine Environmental Studies program began. It was designed to collect biophysical data in Lancaster Sound that could be used to assess the potential environmental impacts of possible hydrocarbon development in remote northern environments.

A long-term program on seal research was established with focus on grey and harbour seals on Sable Island. This program included studies of population dynamics, reproduction, diets and predation on Atlantic cod.

The Scotian Shelf Ichthyoplankton Program was initiated and ran for six years. This monitoring program was designed to measure the properties of larval fish that could be used to improve fisheries recruitment models. Ichthyoplankton were sampled with paired bongo nets at a grid of stations over the continental shelf between George's Bank and the Laurentian Channel. Water samples were also collected for the measurement of temperature, salinity, nutrients and chlorophyll.

The toxicity-testing program expanded further to include newly introduced pesticides used by the forest industry in New Brunswick to control the spruce budworm. Agricultural pesticides were also investigated.

A long-term seabird program was initiated for the conservation and protection of populations of seabirds in coastal waters of eastern Canada. New projects focussed on studying their breeding ecology as well as their distribution while away at sea. Breeding colonies studied ranged from the High Arctic and Hudson Strait to southeast Labrador and eastern Newfoundland. Extensive observations at sea were made from BIO research vessels and aircraft.

1977

The CSS *Hudson* investigated an oil slick off Scott Inlet, Baffin Island and determined it was the result of natural seepage, possibly from truncated sedimentary rock strata that were observed in the submerged walls of the Inlet. Bedrock studies off southern Baffin Island were continued in subsequent years.

The CSS *Baffin* worked off Peru as part of a Canadian International Development Agency sponsored Peruvian fishery project.

Bedform movement in the intertidal zone of Minas Basin was evaluated in a unique experiment using cameras held aloft by a tethered balloon. Experimental vertical pipe traps were developed for beach studies of wind-driven transport. Other studies of sedimentary processes in coastal bays were conducted in Labrador and the Northwest Passage.

Geoscientists participated in projects examining bottom sediments following test manganese mining in the Pacific Ocean and multichannel seismic surveys in the Labrador Sea.

Prior to this year, research had been conducted on the role of fisheries within an ecological context but with reorganization and the creation of the Marine Fish Division the program expanded to include the provision of scientific advice in support of fisheries management.

The International Observer Program was established to monitor commercial fishing activities in Canadian waters. Observers were placed on foreign fishing boats operating on the Scotian Shelf to ensure that Canadian fisheries regulations were obeyed and to collect information for stock assessment purposes.

1978

The demand for scientific information in support of management decisions continued to increase.

With the arrival of the cartographic unit from Ottawa, hydrographers were now able to produce navigation charts at BIO. The Graphical Online Manipulation and Display System, an interactive cartographic system that allowed cartographers to digitize and edit data during chart production, was developed and became part of the national hydrographic system.

Sediment studies in Minas Basin indicated that the high rates of coastline erosion, the massive movement of sands and the net accumulation of muds in the upper part of the Bay of Fundy might create significant difficulties if a tidal barrage were to be constructed.

Work on ocean dumping studies continued and a major study of sediment dynamics in the Saint John, NB, estuary was nearing completion.

Paleo-oceanographic studies employing foraminifera and pollen in sediment cores were conducted on the continental shelf off Labrador and Peru to determine past oceanographic conditions.

A major multidisciplinary study was conducted in the Miramichi Estuary. As a result of the extensive sampling over the annual cycle, it was possible to construct predictive models of sediment fluxes that were used to make estimates of the impacts of discharged sediment and associated chemical constituents.

An intensive study of the Gaspe Current was conducted and a long-term program of current meter moorings in the Laurentian Trough was initiated.

The Cape Sable experiment was initiated to investigate the seasonal and short-term variability of the movement of water from the Scotian Shelf into the Gulf of Maine. An anti-cyclonic gyre over Brown's Bank was discovered.

Further work was done on the development of numerical models of tidal properties of the Bay of Fundy, George's Bank and the Gulf of Maine system that could be used to predict the impacts of proposed tidal barrages in the upper reaches of the Bay of Fundy. Model results were able to reproduce the observed boundaries between well-mixed and stratified areas and changes in tidal regime from inserting barrages were detected.

The storage and retrieval of oceanographic data was carried out in coordination with the Marine Environmental Data Service in Ottawa.

A long-term program was initiated to study the life cycle and variability of sea ice in the Arctic Ocean and off the east coast of Canada.

Moored current meters and repeated CTD surveys were used to estimate the flow into and out of the Labrador Sea across 44 W that could be used as an open boundary condition in a numerical model being developed to describe the formation of Labrador Sea Water through deep convection in the winter. This was the first year that direct observations were made of the formation of Labrador Sea Water.

Chemists collected important baseline data in the eastern Arctic, especially within and adjacent to Baffin Bay.

The Point Lepreau Environmental Monitoring Program was implemented to determine the fate and effects of low-level radioactive wastes expected to be released from the 630 megawatt CANDU reactor under construction at Point Lepreau, NB, on the Bay of Fundy. Baseline radioactivity monitoring was performed on marine, atmospheric and terrigenous samples collected in the vicinity of the reactor site.

A team of biologists and geologists assisted French officials in devising a clean-up strategy for the *Amoco Cadiz* oil spill in Brittany and conducted research on the persistence of spilled oil on the shorelines.

The relationship between photosynthesis and light was determined for natural phytoplankton populations. This approach was later expanded to consider the relationship between photosynthesis and light at intensities commonly inhibitory to photosynthesis. Using both radioactive and stable isotope tracer techniques, studies were conducted to examine the fluxes of nitrogen and phosphorus mediated by natural phytoplankton populations.

Studies on the impacts of building the Canso Causeway indicated that the primary production in Chedabucto Bay was reduced by 15% through loss of nutrient entrainment by estuarine flow.

A seasonal study of grazing by the zooplankton community in Bedford Basin was conducted, including a detailed investigation of carbon and nitrogen utilization during the spring bloom.

Using BIONESS, experiments were conducted on the type and abundance of euphausiids found in the acoustic scattering layers off the coast of Gaspé, QC.

Bioenergetic numerical models were developed to describe the flow of energy through an ecosystem to improve understanding of the production dynamics of fish populations.

In response to continuing interest in the development of tidal power, a new program was launched to investigate the fundamental ecology of the upper reaches of the Bay of Fundy. Focus was placed on Cumberland Basin that was one of the preferred sites for tidal power development. The program was conducted in collaboration with other government laboratories and universities. A large number of physical, chemical and biological variables and processes were measured over annual cycles including suspended and bottom sediments.

Studies on mussel growth and mortality conducted in Bedford Basin found that differences between different stocks had a genetic basis.

Observations of biomass relative to size and predator-prey size relationships led to the formulation of a theoretical ecosystem structure that could be described simply in terms of the standing stocks and sizes of predator and prey and the growth efficiency of their interaction. This biomass spectrum theory of ecosystem structure was used to estimate the potential fish production in the Gulf of Maine and the North Sea.

Using data from the Blandford whaling station, it was determined that whales occurred most frequently at the edges of banks and along the break of the continental shelf where food organisms were most abundant.

A major project on the abundance, habitat usage, breeding and feeding ecology of five species of seabirds on Prince Leopold Island was completed. The results were used in the development of management policy to protect these endangered populations.

Extended fisheries jurisdiction and the associated diminution in the scientific functions of international fisheries commissions led to the creation of the Canadian Atlantic Fisheries

Scientific Advisory Committee (CAFSAC) to provide peer-reviewed advice on fisheries management and a coordinating mechanism for fisheries research.

A study of lobster larvae in St. George's Bay concluded that the construction of the Canso Causeway in 1955 sharply reduced the supply of larvae to Chedabucto Bay and was most likely the cause of the observed crash in the lobster population.

In collaboration with the St. Andrews Biological Station, a program was established to study the changes in temperature on lobster grounds and their effects on lobster populations.

An international study involving Canada, the US, Germany, Poland and the USSR was conducted on larval herring on George's Bank-Nantucket Shoals. It was found that the tidally-induced temperature front oscillated back and forth over the herring spawning beds at the M_2 frequency.

In collaboration with the Northwest Atlantic Fisheries Centre in St. John's, NL, a study was initiated on the life cycle of cod on Flemish Cap.

Tagging programs were initiated for grey and harbour seals to elucidate their migration patterns.

1979

Cooperation in oceanography between Canada and China began when a group of Canadian oceanographers visited 14 Chinese oceanographic institutes and discussed possible collaboration. Numerous scientific exchange visits were carried out in subsequent years.

Geologists initiated a long-term program of mapping the coastline of Canada using aerial reconnaissance which included oblique photo and video coverage with voice commentary and interpretation. Data were stored in an in-house Coastal Information System that evolved into a sophisticated geospatial database system. Initial geographic focus was on the Maritime Provinces and western Arctic.

BIO and Dalhousie geophysicists developed a method to study earthquake waves near Iceland as a contribution to methods to obtain properties of mid-ocean ridges where new lithosphere forms.

Geoscientists completed an interpretation and evaluation of the Sydney Coal Basin on northern Cape Breton Island and offshore beneath Laurentian Channel using onshore mine, offshore well and geophysical survey data. Reserves of 1.6 billion tonnes were identified.

Scientists advised the Regional Environmental Emergencies Response Team on clean-up procedures for the *Kurdistan* oil spill incident. This British tanker broke up in Cabot Strait and released 7000 tons of Bunker C oil into ice-infested waters off Cape Breton.

Scientists participated in the Lomonosov Ridge Experiment and the Fine Resolution Arctic Model I expedition that were organized to study seafloor features in the Arctic Ocean. Both these expeditions were carried out from ice stations established under the Polar Continental Shelf Project.

1980

The A.G. Huntsman Award in marine science was created by BIO scientists on behalf of the Canadian marine science community to recognize excellence of research and contributions to international marine science. The three categories of the Award were marine geosciences, physical/chemical oceanography and biological oceanography/fisheries science. The Award was named after Dr. Archibald Gowanlock Huntsman (1883-1973), a pioneer Canadian oceanographer and fishery biologist who spent most of his distinguished career working out of St. Andrews, NB.

Due to the discovery of oil at Hibernia in 1979, a study of iceberg scours on the north-eastern Grand Banks was initiated using sidescan sonar and the Huntec high-resolution seismic profiler. This program later expanded to include the Labrador and Baffin Island shelves. A comprehensive scour catalogue was developed to assist the oil and gas industry in planned future offshore developments.

The CSS *Baffin* conducted hydrographic surveys in Ungava Bay and along the coast of Labrador. Later, in conjunction with the CSS *Hudson*, a multidisciplinary survey was conducted in northern Davis Strait.

Steps were initiated to develop a comprehensive database named BASIN to curate all the data generated from wells drilled by the oil and gas industry. These data included stratigraphy, lithology, spores, pollen and dinoflagellates. With time, BASIN was in great demand by government, university and industry personnel.

BIO and Memorial University geophysicists used CSS *Dawson* to obtain the first heat flow measurements in fjords and bays offshore eastern Canada showing that standard ocean basin techniques could be used successfully in these nearshore continental shelf environments,

BIO and other scientists prepared site selection criteria and participated in the Baffin Island Oil Spill Project that involved experimental releases of crude oil on the northern end of Baffin Island to investigate the short- and long-term fate and effects of crude oil and chemically dispersed oil on arctic shorelines and near shore environments, as well as to determine the effectiveness of shoreline cleanup techniques.

The CSS *Hudson* conducted a major multidisciplinary cruise to the Arctic. Biological oceanographic observations were made in Lancaster Sound, Baffin Bay and Melville Bay. One station was made at almost 80°N, the most northerly station ever sampled by ship in the Canadian Arctic.

A fifteen-year program, with international collaboration, was initiated to determine the water masses, their origins, circulation, changes and the global importance of the Arctic Ocean. This program collected data using both ships and ice island camps.

The focus of the air-sea interaction program shifted from direct observation of air-sea fluxes to the development of the climatology of winds, air and sea temperatures, clouds and air-sea fluxes over the North Atlantic.

Scientists joined the US-led Seabed Working Group under the auspices of the International Maritime Organization and initiated a six-year research program on the feasibility of disposal of high-level nuclear waste in deep-sea sediments on the Nares Abyssal Plain.

The CSS *Dawson* and the RRS *Discovery* participated in the Lesser Antilles Deep Lithosphere Experiment south of Bermuda to evaluate the potential of deep-sea sediments for the disposal of high-level nuclear waste.

Scientists participated in studies of the effects of cadmium on lobsters from industrial discharge in Belledune Harbour, NB.

Research cruises in the Gulf of St. Lawrence and on the Scotian Shelf surveyed groundfish stocks as part of a continuing program to detail the seasonal distribution of different groundfish species, to refine estimates of population abundance and to provide a basis for future survey design.

Fish tagging experiments were conducted with cod and pollock to provide critically important information on stock structure, inter-relationships and migration patterns.

In collaboration with other local partners, a one-day synoptic survey of water quality in 50 Metro area lakes was conducted using a helicopter to collect samples.

1981

Hydrographers tested an aerial hydrography system at Sable Island from CSS *Baffin*.

Geologists conducted the first reconnaissance of surficial sediments and bedrock on the Grand Banks using the Huntec seismic profiling and sidescan sonar tools with sediment sampling to infer a previous low sea level at 110-120 m and presence of seabed furrows attributed to the scraping of iceberg keels across the seafloor.

BIO and Memorial University geologists focused for several years on a study of surficial sediments and sedimentary processes on northern Grand Bank, a region of oil discoveries and subsequent oil production.

Geologists conducted the first analyses of sedimentary facies on the continental shelf based on sidescan sonar, echo sounding and sample analyses.

Geoscientists hosted a visiting scientist from Nanking University, China. A multiyear study of seabed physical environmental history was initiated based on surface micro-texture of quartz grains beginning on the Labrador Shelf.

Geochemists continued their study of the feasibility of sedimentary nuclear waste disposal in the northeast Pacific Ocean.

A long-term program was initiated to study the stability of the continental slope off Atlantic Canada that was characterized as a complex landscape of countless failed and eroded sediment surfaces. A cruise by CSS *Dawson* provided information about sediment slumping and transport during the 1929 Grand Banks earthquake and the estimated recurrence interval of similar earthquakes.

Using the manned submersible *Pisces IV*, geoscientists from BIO, Dalhousie and Memorial Universities explored in detail the seabed on the Scotian Slope and the Labrador and Baffin Island Shelves, including a natural oil seep.

Geologists reported on Tertiary diatom occurrences in offshore well cuttings collected between Nova Scotia to Labrador as part of a long-term study of Atlantic margin biostratigraphy and geological history based mainly on the evolutionary succession of foraminifera and palynomorphs.

Geologists initiated a long-term program to monitor shoreline response to changing environmental conditions and coastal management activities. Much of the subsequent work was done at a wide network of coastal sites at which semi-permanent markers were established to facilitate repetitive surveys. By 2012, there were 613 such sites in Canada with almost half in the Arctic.

The CSS *Hudson* conducted a nine-month circumnavigation of North America which included passing through the Panama Canal and conducting hydrographic surveys in the Beaufort Sea. This was her second time through the Northwest Passage.

Scientists participated in the Warm-Core Rings Experiment which was an interdisciplinary study of the structure and dynamics of Gulf Stream core rings in Slope Water. This experiment involved approximately two-dozen investigators from thirteen marine institutions.

Using an ice camp, scientists participated in the Eurasian Basin Experiment 81 to learn more about water circulation in the Arctic Ocean.

The first radionuclide studies in the Arctic Ocean were conducted from the FRAM III Ice Station located north of Fram Strait.

Using commercial off-the-shelf equipment, a marine microbial ecology program was begun using flow cytometry. The technique of measuring particles suspended in seawater using the principle of wavelength-specific fluorescence emission following monochromatic excitation allowed for rapid, accurate and precise analysis of plankton cells. This novel technique led to the exciting discovery of the great importance of picoplankton (cells between 0.2 and 2 μm) in the transformation of carbon and energy in the global ocean.

A long-term ecological program was initiated to study phytoplankton and zooplankton in the eastern arctic. A field station was established in Resolute, NWT, and work conducted in Lancaster Sound.

A part of a larger program investigating the structure of gadoid stocks on the Scotian Shelf, a project was initiated to measure and compare the shape of fishes.

1982

Climate change and variability emerged as an important issue that needed to be addressed by the BIO community.

The first hydrographic charts produced at BIO since decentralization from Ottawa were released and covered the Bras D'Or Lakes and the Saint John River.

Initial planning meetings were held to start the development of electronic charts.

An expedition studied the geology and geophysics of the previously unexplored eastern Baffin Island fjords and Baffin Island Shelf.

Collaborative studies of the Labrador Sea rifting evolution by BIO, Scandinavian and US geophysicists documented volcanic igneous bedrock offshore eastern Baffin Island and western Greenland.

BIO geophysicists showed that marine magnetic field values measured on multiparameter cruises fitted the 1980 International Geomagnetic Reference Field better than earlier reference fields. CSS *Baffin* continued systematic multiparameter surveys of shelf, slope and rise from George's Bank to the Grand Banks of Newfoundland while incorporating sedimentary studies around Sable Island and Grand Bank. Marine geophysicists introduced automatic computer contouring of data and produced a gravity map from the Scotian margin to Davis Strait.

The CSS *Hudson* conducted a mid-winter expedition to study the physical oceanography of the region between Iceland and Spitsbergen in the Norwegian-Greenland Sea.

Atlases were published incorporating physical and chemical oceanographic observations made in the Gulf of St. Lawrence, South Atlantic, Drake Passage, Pacific Ocean, Arctic Ocean, Denmark Strait and Gulf Stream.

The 10-m underwater electric rock drill was used successfully on CSS *Hudson* to obtain the first sedimentary bedrock samples in Hudson Strait and on the Baffin Island Shelf. Analyses of the cores suggested the northeast Baffin shelf is a potential area for hydrocarbon resources.

1983

Using CSS *Hudson*, staff completed a sidescan sonar survey of the epicentre of the 1929 Grand Banks earthquake on the continental slope south of Newfoundland.

Geologists established the Sedimentology of Arctic Fjords Experiment that investigated sediment processes and fluxes in fjords of eastern Baffin Island. The results contributed significantly to global understanding of the complex sediment and biological processes operating in fjords.

Scientists conducted research under the Northern Oil and Gas Action Plan that was created to increase the capability of government to assume its environmental responsibilities in the event of large-scale developments of oil and gas resources in the Canadian Beaufort Sea region.

Geoscientists documented high arctic shore zones using airborne colour video and voice description in conjunction with a CSS *Baffin* marine geology, geophysics and hydrographic survey of Jones Sound. Such surveys, extended to many regions of arctic and eastern Canada, provided input for scientific coastal analysis, oil spill contingency planning and other applications.

Numerous scientists participated in the Canadian Expedition to Study the Alpha Ridge (CESAR) in the Arctic Ocean and conducted geological, chemical and biological research from an ice island camp established by the Polar Continental Shelf Project.

Staff participated in the Marginal Ice Zone Experiment '83, an international, interdisciplinary study of marginal ice zones between Greenland and Svalbaard.

With assistance of European and university colleagues, a project was begun to develop a numerical model to simulate the dynamics of the Cumberland Basin ecosystem in the upper reaches of the Bay of Fundy, one of the sites being considered for tidal power development. This was the first such estuarine simulation model developed in North America.

Using similar techniques, another new project was initiated in collaboration with Canadian and European colleagues to develop a numerical simulation model of the Grand Banks pelagic ecosystem that could be used to explore the potential effects of an oil spill at Hibernia.

Experiments were carried out in the Sargasso Sea to determine if iron might be the limiting nutrient for phytoplankton photosynthesis. The results were negative indicating that purposeful enrichment with iron would not increase the drawdown of carbon dioxide from the atmosphere.

The three-year multidisciplinary Fisheries Ecology Program, designed to describe the population dynamics of haddock stocks, was initiated on Browns Bank. It was similar to the previous St. Margaret's Bay study in its holistic approach to ecosystem research but differed by focussing on a particular fish stock.

1984

Staff participated in the hearings concerning the Gulf of Maine boundary dispute before the International Court of Justice in Den Hague. Prior to the court proceedings, staff prepared a series of technical documentations and provided advice to the Department of External Affairs.

Staff assisted the development of Korean oceanography through a series of exchange visits with the Korean Ocean Research and Development Institute.

Numerous projects were conducted that increased scientific understanding of the potential effects of climate change. These included studies of carbon dioxide flux between the atmosphere and ocean, year-to-year differences in arctic ice cover, variability of ancient climates as recorded in deep-sea sediment and the influence of between-year variability on the reproduction of fish stocks.

Geologists were mandated to assess the oil and gas potential of offshore regions and to expand studies of the sedimentary basins.

An index and catalogue of marine gastropods and pelecypods in eastern Canada, including offshore shelf samples from BIO cruises, was released.

A comprehensive review of all geological data pertinent to the Labrador Shelf was conducted and compiled into a Quaternary sediment map.

Geoscientists on CSS *Hudson* interpreted deep seafloor sedimentary processes throughout the Labrador Sea from echo sounding and seismic profiles as part of the assessment of sites for the international Ocean Drilling Program.

The five-year Canadian Ice Island program was initiated to conduct oceanographic and geoscientific studies of the ice-covered polar margin between Ellesmere Island and the Beaufort Sea. A permanent ice camp was constructed by the Polar Continental Shelf Program to conduct multidisciplinary programs including seismic surveying, seabed sampling, heat flow measurement, plankton and benthos surveys, physical and chemical oceanography, meteorology, atmospheric sampling and ice strength studies.

Staff were major participants in the pilot Humidity Exchange Over the Sea experiment that was carried out in the North Sea off the coast of The Netherlands.

Studies were carried out on the mixing rate in the ocean interior of the large tongue of warm salty water that passes from the Mediterranean Sea into the North Atlantic Ocean through the Strait of Gibralter.

The CSS *Hudson* conducted a multidisciplinary winter survey in the Gulf of St. Lawrence to collect data to compare seasonal variations in biological, chemical and physical processes.

A joint Canadian and Danish project, using CSS *Baffin*, investigated a large spill of plutonium at Thule, Greenland, resulting from the 1968 crash of a US B-52 bomber carrying nuclear weapons.

Biologists counted and tagged grey seal pups on Sable Island.

1985

Staff participated in the US/France expedition on the RV *Knorr*, operated by the Woods Hole Oceanographic Institution, that discovered the wreck of the RMS *Titanic* off the Tail of the Grand Banks.

Geophysicists documented improved performance of new sea-going gravimeters for use on multiparameter hydrographic regional surveys.

Geologists completed an aerial video survey of the entire coastline of the Beaufort Sea from Tuktoyaktuk to the Alaska border to provide information on the long-term rates of coastal erosion.

Geologists compiled and mapped the detailed surficial geology of the Hibernia area of northeast Grand Bank in support of seabed hazard assessment for safe hydrocarbon development. Surveys continued for several years to include the uppermost bedrock that is the foundation for hydrocarbon production structures.

Geochemists participated in an international expedition on the French research vessel RV *Marion Dufresne* to the Great Meteor East Abyssal Plain and obtained the longest piston core of deep-sea sediments ever collected.

CSS *Hudson* cruises with geoscientists documented bedrock and surficial geology of the southern Grand Banks, parts of Hudson Strait and Cumberland Sound on Baffin Island.

Numerical models were under development to predict ice conditions at the Hibernia oil field on the Grand Banks.

Scientists participated in the international Marginal Ice Zone Experiment aboard the German icebreaker FS *Polarstern* in the Fram Strait between Spitzbergen and Greenland.

Petroleum geologists produced estimates from industry offshore well data of probable geological conditions for oil and gas formation beneath the southern Grand Banks, as well as subsurface stress orientations beneath the Scotian Shelf.

Under-ice studies of phytoplankton and zooplankton were carried out in Lancaster Sound.

The particle size distributions of pelagic ecosystems in Hudson Strait and on the Labrador Shelf were studied on a cruise of the CSS *Hudson*.

Using the CSS *Baffin,* scientists collected data on seals and phytoplankton physiology in the front of the ice fields off Labrador in collaboration with the Smithsonian Institution and the Northwest Atlantic Fisheries Centre.

The Atlantic research directors of Department of Fisheries and Oceans established a Working Group on Fisheries Oceanographic Requirements that met regularly for three years.

1986

With the establishment of the new Department of Fisheries and Oceans fish habitat policy, steps were initiated to improve the linkages between habitat scientists at BIO and the staff of the regional Habitat Management Branch based in the Hollis Building in Halifax. This led to the creation of the Marine Assessment and Liaison Division at BIO.

Hydrographers tested the efficiency and feasibility of transmitting and receiving mapping information via the ANIK-D Satellite Network.

Geoscientists and collaborators published information on the surficial geology of Labrador Shelf and correlated offshore glacial sedimentary units to onshore units.

Coastal geoscientists from BIO and Irish universities examined the similarities and differences between Nova Scotia and Ireland of sedimentary systems on previously glaciated North Atlantic coasts.

The Canadian Atlantic Storms Program field project was conducted over Atlantic Canada in conjunction with the American Genesis of Atlantic Lows Experiment. The goals were to begin the process of understanding and eventually better predicting the mesoscale structure of intense Atlantic storms.

A major study of the physical and chemical characteristics of the eastern Grand Banks was carried out using CSS *Hudson.*

Organochlorine contaminants (e.g. DDT, PCBs) were measured in air, seawater, ice, snow, sediment, ice algae, phytoplankton and zooplankton collected at the Canadian Ice Island. The ubiquitous presence of these industrial contaminants in a remote environment distant from their sources emphasized the global nature of atmospheric transport.

A joint venture with Extremely Low Frequency/Aquitaine of France examined the sublethal effects of petroleum hydrocarbons on juvenile Atlantic salmon.

Scientists co-led a national review of physical and chemical sciences programs for the ADM of Science of the Department of Fisheries and Oceans.

1987

Work continued on the development of a Climate Research Strategy to include various major international programs, departmental interests and collaboration throughout the scientific community.

Hydrographic surveys were conducted on the Scotian Shelf to upgrade survey data for the production of new charts to meet the demands of the fishing and offshore oil and gas industries.

The Dial-A-Tide Program was developed in partnership with a local consulting firm. This service allowed the public free access to tidal information through the telephone system.

The first electronic charts were developed.

Geologists successfully completed tests of the Long Coring Facility that enabled the recovery of core samples up to 20 m in length.

A field study was completed of the mixing and dynamics in the Newfoundland Basin where the Gulf Stream and the Labrador current systems interact and influence the large-scale climate of this region.

Current meter moorings and field surveys were used to determine water exchange between Baffin Bay and the Northwest Atlantic as part of a regional ice modelling experiment.
Staff participated in the Labrador Ice Margin Experiment. Ice beacons were placed on the Labrador ice sheet to track the southward advection as part of the sea ice climatology and modelling for the Hibernia area.

A scientific evaluation of the likely environmental impacts of exploratory drilling on the George's Bank ecosystem was completed for the Gulf of Maine Advisory Committee.
In response to the molluscan toxin emergency in Prince Edward Island, BIO staff participated with other agencies in identifying the toxin as domoic acid and determining the source as a common marine diatom.

Algorithms were developed to more effectively utilize satellite data to estimate global productivity of the oceans.

Using the results of eight cruises and forty-five publications from recent BIO research, a synthesis was prepared of recent advances in biological oceanography of Arctic waters.
Under the sponsorship of the International Centre for Ocean Development, a course on innovative stock assessment was organized and presented in Dakar, Senegal.

1988

The first multibeam echo sounder was installed on the CSS *Frederick G. Creed*. These systems, which had been under development since the 1970s, transmitted multiple acoustic beams beneath and to both sides of the survey vessel providing the ability to map 100% of the sea floor. This new technology revolutionized hydrographic surveying and allowed photograph-like images of the seabed to be created and mathematical representations of the seabed to be generated.

In collaboration with Brock University, geologists conducted a geophysical interpretation of the magnetic anomaly of the Labrador Sea and Orphan Basin in order to understand the nature of the region's underlying bedrock and decipher the history of the rifting that created the continental margin and subsequently affected the development of the sedimentary basins on the continental shelf.

Geophysicists developed methods for retrieving and cataloguing large sets of marine magnetic and aeromagnetic data from other countries for compilation of maps of the magnetic field over the North Atlantic and Arctic oceans. By 1990, 20 organizations in eleven countries had provided data.

The first five years of the Frontier Geoscience Program were completed and the Labrador Sea Basin Atlas was published. This was the first of several basin atlases synthesizing the history of the formation of sedimentary basins off Atlantic Canada.

Geological input was provided to the development of a new hydrocarbon appraisal for the Jeanne d'Arc Basin on the northeast Grand Banks.

Deep crustal seismic studies carried out under the Canada/Germany bilateral agreement provided new evidence on the formation of east coast continental margins and the associated marginal basins.

Marine geophysicists began a long-term program to compile and develop a new database of coherent magnetic observations from Arctic and North Atlantic oceans.

In response to the PEI molluscan toxin emergency, a five-year expanded regional program on marine phycotoxins was initiated using new resources from Ottawa. In addition to BIO, other regional participants included the Atlantic Regional Laboratory of the National Research Council, the Halifax Fisheries Research Laboratory, the St. Andrews Biological Station and the Gulf Fisheries Centre. This program considered the identification of phycotoxins, their sources, their detection and how to manage the problems they posed.

Substantial progress was made in understanding the biochemistry, physiology and ecology of toxin-producing phytoplankton. A phytoplankton profiling program was initiated to determine the phytoplankton composition of selected inlets on a regular basis to determine the areas that are unfavourable for aquaculture due to the presence of toxin-producing species.

Stimulated by environmental concerns over drilling for hydrocarbons, numerous physical, chemical and biological studies were initiated on George's Bank. These included the George's Bank Frontal Study which examined circulation and mixing associated with the tidal front as well as turbulence, plankton production and larval distribution in the frontal area.

A multidisciplinary environmental study of Halifax Harbour was begun to provide information that could be used in designing a regional sewage treatment system. Studies included physical oceanography, the morphology and chemical contamination of sediments, benthic communities, trace metals and contaminants in lobsters.

In response to concerns about the environmental impacts of aquaculture, a new multidisciplinary program was undertaken in collaboration with the St. Andrews Biological Station that employed field data coupled to ecological modelling techniques to examine the environmental impacts of salmonid aquaculture in the L'Etang Estuary in southwestern New Brunswick.

A research program on silver hake was initiated to aid in the management of this resource and to study its role in the Scotian Shelf ecosystem.

1989

Four BIO scientists were appointed to the Halifax Harbour Task Force created by the Province of Nova Scotia to develop recommendations for designing a regional sewage treatment system.

A second set of east coast trials with the Hysub 5000 ROV was carried out using CSS *Dawson*. Experiments were carried out to examine sewer outfalls, zooplankton, and scallop and lobster habitats. The distributions of dredge spoils were also mapped.

The CSS *Baffin* completed an extensive multiyear hydrographic survey of the Labrador Coast that focused on the shipping lanes between Hamilton Inlet and Nain.

Hydrographers participated in the North Sea Electronic Chart evaluation trials during which their electronic chart test bed was demonstrated.

Geologists implemented two new programs of enhanced coastal studies. The Marine Geoscience Initiative was designed to provide an integrated national approach to research on coastal geological problems, while at the same time addressing specific issues relating to urban and commercial development. The Global Change Initiative was designed to provide impetus for research on environmental change records in marine sediments, carbon fluxes and sea-level changes.

In collaboration with the French Research Institute for Exploitation of the Sea, geologists carried out a study of continental slope stability in the Mediterranean Sea off Nice using the Huntec DTS seismic profiling system.

Geologists participated in Leg 123 of the international Ocean Drilling Program that drilled a transect of holes from the Exmouth Plateau west of Australia to the Argo Abyssal Plain in the Indian Ocean. This program succeeded the highly successful Deep Sea Drilling Program and employed the drill ship *Joides Resolution*.

In collaboration with university scientists, the Littoral Investigation of Sediment Properties program was initiated to improve understanding of the interrelationships among the physical, geological, chemical and biological properties of intertidal sediments. The study examined the processes by which fine-grained sediments were formed and the relationship of atmospheric factors to the stability of exposed tidal flats.

The CSS *Baffin* conducted multiparameter surveys off Nova Scotia on closely-spaced lines to compare new BIO and Lamont Doherty Geological Observatory gravimeters installed side-by-side and to evaluate the origin of errors in both gravity and magnetic field measurements.
Under severe weather conditions, the CSS *Baffin* successfully carried out a much abbreviated survey of temperature, salinity and chemical tracers in the Greenland Sea Gyre. This was the Canadian contribution to the Greenland Sea Project coordinated by the Arctic Ocean Sciences

Board. The goal of the project was to determine how much surface water was cooled during the winter and sinks to form deep water.

As part of the Labrador Ice Margin Experiment, CSS *Baffin* conducted a survey of pack ice off the Newfoundland and Labrador coast. In cooperation with the Atmospheric Environment Service, two flights with synthetic aperture radar were conducted to obtain microwave images of ice distribution. In addition, the Centre for Cold Ocean Resources Engineering of Memorial University deployed a sonic sensor for measuring ice ablation and collected ice-melt data. The CSS *Dawson* successfully recovered an array of year-long current meter moorings from Davis Strait and deployed replacements. The moorings were designed to measure water transport out of Baffin Bay into the Labrador Sea.

As part of the national Long Range Transport of Atmospheric Pollutants program, a monitoring program was created to follow long-term changes in the water chemistry and biological communities in selected lakes in Kejimkujik National Park.

As part of the international Joint Global Ocean Flux Study pilot experiment in the western North Atlantic, scientists examined the northern progression of the spring phytoplankton bloom and ground-truthed satellite measurements of chlorophyll in the Sargasso Sea and east of Flemish Cap.

A study was carried out on the role of zooplankton in exporting nitrogen out of the surface layers of the ocean during their diel migration.

Some scientists became part of the Ocean Production Enhancement Network under the Networks of Centres of Excellence program funded by the Natural Scientific and Engineering Research Council. The principal goal was to investigate the processes which controlled the reproduction, survival, growth and distribution of Atlantic cod and sea scallops.

Grey seal population trends were studied by tagging all pups born on Sable Island. In cooperation with Guelph and Dalhousie Universities and Fisheries Resource Development Ltd., a research program was initiated to investigate the deworming of seal populations, the immunological relationships between seals and seal worms and the use of birth control agents to reduce grey seal populations.

Positive steps were taken to improve the interaction between scientists and fishermen. These included seminars, opportunities for fishermen to join research surveys and for scientists to join fishing vessels and provision of printed material to fishermen on a regular basis.

Fisheries biologists examined the implications of changing trawl net mesh size and shape on the operation of commercial fisheries.

1990

With the arrival of multibeam technology, research and testing were conducted to develop software and procedures to ensure accurate depth data were logged and processed and that the massive amounts of data generated by the system were properly archived. The research, conducted in collaboration with industry and the University of New Brunswick, included measurements of vessel motion and speed of sound along the beam path to determine vertical depths. This work led to the development of a high precision motion sensor and the adaption of the moving vessel profiler for continuous speed-of-sound measurement.

The marine Digital Initiative Project for sidescan sonar and seismic data was initiated by geologists to provide the basis for the repeatable, quantitative and geographically accurate mapping of the seafloor and underlying sediments needed for environmental assessment, seabed mapping and pollution monitoring.

Geologists participated in Leg 131 of the Ocean Drilling Program to the Nankai Trough which examined the subduction of the Philippine Sea Plate below the Honshu Arc in the Pacific Ocean. In collaboration with the University of Maine, geologists studied the shallow geology of the Gulf of Maine to determine how it developed from a basin filled with glacial ice into the biologically productive body of water that it is today. This project used the Huntec DTS seismic system to provide high-quality profiles of the seafloor and subsurface.

The Scotian Shelf Basin Atlas was published, the second in a series synthesizing geoscience knowledge of frontier sedimentary basins. The atlas covered bathymetry, surficial geology, structural geology, geophysical parameters, biostratigraphy, seismostratigraphy and paleoenvironmental conditions throughout the period of formation.

Geologists completed their final cruise in the Halifax Harbour program. A digital sidescan sonar survey provided detailed information about the harbour floor and a ROV with cameras investigated sites of particular interest. The resulting geological maps were useful in the design and construction of the new regional sewage treatment system.

A CSS *Hudson* cruise to Sable Island Bank provided a valuable data base on sediment stability and the internal fabric of the sands comprising the bank. Vibracores, box cores and large grabs of bottom sediment, collected across the postulated position of a ‘hydraulic fence’, demonstrated a dramatic change in sediment type.

In collaboration with colleagues from the French Research Institute for Exploitation of the Sea, geologists investigated slope stability and debris flows on the continental margin of the southeast Grand Banks onboard the CSS *Hudson* using the French high-precision digital sidescan system and the Canadian Huntec DTS seismic system.

Geoscientists produced *Geology of the Continental Margin of Eastern Canada*, a book synthesizing all earth science aspects of the coastal, shelf, slope and ocean basin zones including constraints to their development. The book was part of a multi-volume series for the Geology of Canada and the Decade of North American Geology.

Canadian and Soviet Union geologists collaborated to produce the first circumpolar map of Quaternary deposits in the Arctic Ocean from 65°N to the North Pole. The map, which was produced using the Canadian CARIS computerized geographic information system, was released to the public during the visit of President Gorbachev to Ottawa.

Scientists participated in an international expedition aboard the Russian research vessel *Akademik Keldish*, equipped with two Mir submarines, to examine the wreck of the RMS *Titanic* and collect samples for research on corrosion mechanisms.

Fundamental and applied studies of Foraminifera shifted emphasis to gaining more comprehensive understanding of the potential impacts of climate change on Canadian marine environments.

On the first cruise after an extended mid-life refit, CSS *Hudson* worked in the region of the Southeast Newfoundland Ridge to gain a quantitative understanding of the role of ocean currents in transporting heat from southern latitudes to the northern North Atlantic. A seven-mooring current meter array was recovered and various measurements of temperature, salinity, dissolved oxygen, and nutrients were taken.

The Labrador Sea Monitoring Program was initiated to collect and analyze physical, chemical and biological oceanographic observations on a line of stations across the Labrador Sea from Hamilton Bank to Cape Desolation on the Greenland Shelf. It was subsequently occupied annually (typically in May), and biological measurements added in 1994.

Geochemists participated in a cruise on the German research vessel RV *Meteor* to determine the background distribution of trace inorganic contaminants in the major deep-water masses of the Atlantic Ocean as part of a multiyear project led by the Intergovernmental Oceanographic Commission.

The successful recovery of two sediment traps moored under Canada's Ice Island research station provided the first annual record of particulate matter sedimentation in the Arctic Ocean. The abundance and distribution of euphausiids, an important winter food source for silver hake, was investigated on the Scotian Shelf during a cruise of CSS *Dawson* using a Batfish-mounted optical plankton counter, the BIONESS plankton net sampler and multifrequency acoustics.

Work continued on a project to examine the population structure of sea scallops in the Bay of Fundy and on George's Bank, Western Bank and St. Pierre Bank using morphological traits. Research on lobster migrations in the Gulf of Maine area continued and three common elements were observed. The vast majority of tagged animals were recaptured near the point of release, long-distance return migrations occurred and just a small percentage of animals moved very long distances in what appeared to be one-way dispersal.

In collaboration with Acadia University, an experiment was conducted to determine the impacts of otter trawling on intertidal benthic habitat and communities in Minas Basin.

1991

Under the Canadian Ocean Mapping System, a cooperative venture between government, industry and universities to enhance ocean mapping capability in the private sector through technology transfer, the remotely operated semi-submersible DOLPHIN, equipped with a new multibeam sonar system and a launch and recovery system, was transferred to industry.

Geologists initiated a collaborative program with Hydro-Québec to examine the cumulative environmental impacts of the proposed Grande Baleine hydroelectric development in James Bay. Geologists began collaborating with scientists from Dalhousie University and University of Michigan to reveal the sedimentary history of northern Lake Huron and Georgian Bay.

The two-year Ellesmere Ice Shelf program was begun in the Arctic Ocean.

The CSS *Hudson* conducted the initial cruise of the second Canadian Atlantic Storms Program on the northern Grand Banks near Hibernia. A mooring array was deployed, a hydrographic survey was conducted and surface drifter studies were carried out along the in-shore edge of the Labrador Current. Batfish and acoustic Doppler current profiler transects were made across the Labrador Current to compare with synthetic aperture radar measurements made by aircraft.
As part of the World Ocean Circulation Experiment, the CSS *Hudson* was involved, in cooperation with ships from other nations, in activities to define water transports into and out of the northwest Atlantic Ocean.

Scientists participated in Arctic '91, an international scientific expedition to the Arctic Ocean involving the Swedish icebreaker IB *Oden*, the German icebreaker FS *Polarstern* and the US icebreaker USCGC *Polarstar*. The scientific programs addressed the origin and circulation of water masses, the radiation properties of sea ice, processes involved in cloud formation, the history of seafloor spreading and the history of the region's climate. Both IB *Oden* and FS *Polarstern* reached the North Pole which was a first for conventionally powered ships.

In collaboration with McGill University, scientists developed a computer model that could be used to study the long time-scales of interest to modellers of ocean climate. The model's key innovation was its ability to efficiently represent the circulation of individual ocean basins by using zonally averaged equations of motion so that the resulting global ocean model yielded a realistic representation at sensitivities found in much more sophisticated and expensive models.

As part of the Joint Global Ocean Flux Study, biologists onboard CSS H*udson*, in cooperation with ships from other nations, investigated oceanographic events surrounding the spring bloom of phytoplankton, a brief period of intense biological activity in the oceans that accounts for a substantial fraction of the year's total primary production.

Biologists participated in a cruise of the RV *Cape Hatteras* as a part of the US-sponsored South Atlantic Bight Recruitment Experiment to develop techniques for measuring the concentration of Atlantic menhaden eggs which was important information required by stock assessment scientists.

At the invitation of Exxon, several BIO scientists visited Prince William Sound, Alaska, to assess the effectiveness of the cleanup program conducted after the 1989 *Exxon Valdez* crude oil spill. Once heavily contaminated shorelines showed few traces of remaining oil.

Several BIO scientists participated in the Northern Contaminants Program that was established to address concerns about elevated levels of persistent contaminants in the traditional diets of northern Aboriginal peoples.

Using grappling gear, the CSS *Alfred Needler* conducted a survey of abandoned ghost nets on George's Bank and recovered a substantial amount of fishing gear .

In collaboration with other local partners, a second one-day synoptic survey of water quality in 50 Metro area lakes was conducted using a helicopter to collect samples.

In response to the collapse of the groundfish industry in Atlantic Canada, the Atlantic Fisheries Adjustment Program was created and new projects were funded to increase cooperation between fishermen and scientists, develop an improved understanding of how environmental factors influence fish populations, study the effects of seals and seal worm on fish populations and quality, study the effects of longline fishing on fish populations, study the effects of gillnets and trawling on habitat and improve DFO's scientific surveys.

1992

Hydrographers conducted surveys of Halifax Harbour and approaches using state-of-the-art multibeam echosounders and acoustic sweep systems that produced complete images of the seafloor through image processing software developed by BIO and the University of New Brunswick. Uncharted features and potential hazards to navigation were identified as were various sea-floor features that will assist in the development of theories on post-glacial rebound, climate change and sea-level variations.

Using data from seismic surveys, exploratory wells and outcrop sections, geologists carried out an analysis of the hydrocarbon potential of the Fundy Basin, one of a series of rift basins occurring along the eastern margin of North America that were formed during the early Mesozoic breakup of the supercontinent Pangaea. Some thick lacustrine sequences were identified that might contain petroleum resources.

Geologists were involved in the analysis and interpretation of geochemical data from exploration wells drilled in the vicinity of Sable Island. Some of the source rocks for the oil and gas discoveries made to date were identified. Of significance was the fact that hydrocarbons from many of the mature source rocks had not been identified in discoveries to date, suggesting the existence of sizeable undiscovered resources.

Geologists carried out a cruise on CSS *Hudson* to Hudson Bay and James Bay to collect geological, sediment geodynamical, geochemical and biological information that was required to evaluate the environmental impacts of Hydro-Quebec's proposed Grande Baleine hydroelectric power generation project.

Using new capabilities for sidescan seafloor mosaic construction and wide-diameter piston coring, geologists conducted a study of pockmarks on the Scotian Shelf using CSS *Hudson*. It was concluded that the pockmarks result from seafloor subsidence due to venting of subsurface fluids and gases.

Geoscientists, in collaboration with others, studied the offshore geology of Nares Strait and Smith Sound, between Canada and Greenland, and along the inner shelf of the Eastern Shore of Nova Scotia.

Geoscientists examined the potential for placer gold deposits off northeast Newfoundland as part of the Canada-Newfoundland Mineral Development Agreement.

Geoscientists began a study of the neotectonics of the Lake Ontario lakebed as part of the reassessment of the stability of the region necessary for nuclear power generation.
Analysis of historical hydrographic data from the Scotian Shelf and Gulf of Maine revealed that the dominant low-frequency oceanographic event was a cooling and subsurface freshening of the water masses from 1952 to 1967 followed by a reversal of these trends. These trends were later attributed to changes in the strength and pattern of the Labrador Current.

The George's Bank Steering Committee for Research was created to coordinate the many research projects addressing the George's Bank drilling issue. Membership included the federal government (Fisheries and Oceans, Environment Canada, Natural Resources Canada and the National Energy Board), provincial representatives from New Brunswick and Nova Scotia, Dalhousie University, LASMO Nova Scotia and Texaco Canada, the Canada-Nova Scotia Offshore Petroleum Board and the Seafood Producers Association of Nova Scotia.

In collaboration with LASMO Nova Scotia, scientists conducted a monitoring study of particulate drilling wastes at the Cohasset-Panuke offshore oil production site on Sable Island Bank. The purpose was to investigate the dispersion, deposition, and ultimate fate of the muds and cuttings that the operator was permitted to discharge into this high energy, shallow water continental shelf environment.

Also in collaboration with LASMO Nova Scotia, geologists conducted a study of extreme sediment transport and scour effects during winter storm conditions at the Cohasset- Panuke site.

As part of the international Joint Global Ocean Flux Study, biologists undertook a trans-Atlantic cruise between Halifax and Morocco aboard CSS *Hudson* to investigate primary and secondary production processes in the upper ocean and their role in the global ocean carbon cycle. This was a cooperative venture between Canadian, Italian, German and Spanish scientists.

While periodic observations of many kinds had been made in Bedford Basin since BIO opened in 1962, a formal Bedford Basin Monitoring Program was initiated to record the state of the plankton ecosystem on a sustained basis and determine ecological changes over long periods of time. Weekly measurements were initiated of selected properties that characterize the physical, chemical, biological and optical environments of the water column.

Using new information technologies, a computerized data management system was developed for the management of data from surveys and censuses of colonially breeding seabirds in Canada. It became an essential tool for planning and managing coastal marine environments, monitoring seabird populations in Canadian waters and environmental impact assessment studies.

1993

As part of the program to develop electronic charts, an electronic chart facility was demonstrated at the Marine Simulation and Ship Manoeuvrability Conference and a second test bed installation was placed on the Marine Atlantic ferry MV *Princess of Acadia* operating between Saint John, NB, and Digby, NS.

A desktop study by hydrographers and geologists demonstrated that Canada could possibly extend its seabed jurisdiction in both the Atlantic and Arctic Oceans under Article 76 of the United Nations Law of the Sea by an area equal to the three Prairie Provinces.
An extensive geophysical and geological digital database covering offshore sedimentary basins from George's Bank to the Arctic Ocean was donated by Husky Oil and Petro-Canada.

Geophysicists participated in Arctic '93, a joint project with the US Geological Survey conducted from the US icebreaker USCGC *Polar Star*. Refraction data were collected in the Canada Basin which improved understanding of the Basin's crustal structure.

Geologists completed a 10-year program of repetitive seafloor mapping in the Beaufort Sea. Over 5000 new sea-ice scour events were documented, providing information on their distribution, characteristics and the processes involved. The results of this program provided key input to the evaluation of sea-ice scour risk and engineering design of potential future hydrocarbon production facilities.

Also in the Beaufort Sea, geologists completed a multiyear study of shoreline retreat, sedimentary dynamics, coastal geology and geotechnics. The results were applied to pipeline engineering, environmental protection, community planning and climate change issues.

In collaboration with colleagues from the United States and Europe, geologists gathered geological and geophysical data between Iceland and eastern Greenland using CSS *Hudson*. Topics investigated included the role of turbidity currents and debris flows in fjord sediment transport, the role of iceberg/sea ice shelves fronting larger tidewater glaciers and their effect in controlling sedimentary processes within fjords, the role of iceberg calving and rafting on sediment accumulation distal from the ice margins and the role of subglacial sediment transport through a fjord and onto the continental slope during periods of ice sheet expansion.

In collaboration with the Centre Géoscientifique du Québec, Université de Montréal and the University of Colorado, geologists carried out geological and geophysical investigations in Hudson Strait and Ungava Bay to increase understanding of the late Quaternary geology and history of the region and acquired data relating to global climate change.

Geologists from BIO and Dalhousie University used multibeam sonar bathymetry mapping in Lake Ontario and discovered drumlins preserved in deep water of the basin and ash detritus on former steamship routes.

The final surveys of the North Atlantic Tracer Release Experiment (NATRE) field program were carried out in the Canary Basin by the CSS *Hudson* and the RRS *Darwin*. NATRE was an international study of the rate of mixing and dispersion of ocean waters in the eastern North Atlantic being conducted by scientists from the US, UK and Canada as part of the World Ocean Circulation Experiment.

Chemists participated in investigations of radioactivity in the Arctic Ocean. A cruise on the Russian research vessel RV *Geolog Fersman* investigated radioactive waste dumpsites in the Barents and Kara Seas while a cruise aboard CCGS *Larsen* collected samples for the determination of various radionuclides in seawater and marine sediments.

As part of a program organized by the Intergovernmental Oceanographic Commission, the CSS *Hudson* conducted a large-scale survey of contaminants in the North Atlantic Ocean. The purpose was to determine the present day distributions of contaminants in the oceanic water masses that can provide baseline concentrations for assessing future changes and be used to establish reference levels for coastal zone monitoring.

In collaboration with the Northwest Atlantic Fisheries Centre, a three-year experiment was initiated by a team of engineers, geologists, ecologists and fisheries biologists to investigate the impacts of otter trawling on the benthic habitat and communities at an experimental site on the Grand Banks. Benthic imaging and sampling were conducted by the CSS *Parizeau* while the CCS *Wilfred Templeman* carried out the experimental trawling. This was the first such large-scale experiment of this nature conducted anywhere in the world.

A decision support system was developed to assist managers in assessing the environmental impacts of salmonid aquaculture and evaluating licence applications based on the potential habitat damage. It utilized three separate environmental impact models involving oxygen demand, benthic loading and eutrophication.

The Sealworm Intervention Program was initiated as a cooperative effort with Dalhousie University. This long-term research project investigated chemical and immunological methods to control seal worm infestation and grey seal reproduction.

Scientists began to participate in Gulfwatch, a long-term chemical contaminant monitoring program run by the Gulf of Maine Council on the Marine Environment. Numerous contaminants, including mercury, were measured in blue mussels collected at coastal sites on both sides of the international boundary around the Gulf of Maine.

Fisheries scientists began to put more emphasis on research dealing with the ecosystem approach to fisheries management. At the same time they were addressing the rebuilding of depleted fish populations and limiting the fishery impacts on other ecosystem components.

1994

Hydrographers developed the Spatial Data Option, an extension of the Oracle database software which enabled scientists to access and manage huge volumes of multi-dimensional data about a wide range of geographical subjects. This technology gained international attention.

Hydrographers, together with numerous partners, continued to carry out high-resolution multibeam bathymetric surveys along the Atlantic coast, including mapping corridors for underwater communications cables and pipeline routes.

Geologists participated in Leg 155 of the Ocean Drilling Program on the drill ship *Joides Resolution*. Thirty-four holes were drilled in rapidly accumulating sediments off the mouth of the Amazon River and these provided a record of ocean and continental climate change over the past 60,000 years with a resolution of about ten years.

As part of a three-year program funded under the joint Nova Scotia Mineral Development Program, geologists surveyed part of the Scotian Shelf with high resolution seismic and sidescan sonar to assess offshore sand and gravel deposits. Resource potential was confirmed and bulk samples were collected for material strength testing.

Geologists established a coastal information system to manage and distribute coastal geomorphologic data.   Twenty-two national topographic series map sheets were prepared at a scale of 150,000 throughout the Atlantic Provinces and more were planned in collaboration with provincial and federal departments.

Geologists participated in an expedition using the US submersible *Edwin Link* in the Saguenay Fjord, QC, to investigate the age of several recently discovered turbidite channels and to observe the recovery of benthic communities from the cessation of pulp mill organic waste discharge in the early 1970s.

Using recent technological advances including improved radiocarbon dating, better seismic systems, use of computers for data manipulation and visualization and the application of multibeam sonar to geological mapping, geologist began to study offshore glacial history and relative sea-level changes over the past 20,000 years off Atlantic Canada.

Geographic data including depth, width, length, volume and surface area were compiled for 104 coastal inlets in Nova Scotia and used to sort inlets into groups with similar environmental characteristics. This information enabled investigators to infer the circulation and stratification of inlets not yet sampled and helped focus future fieldwork on inlets for which more detailed information was needed.

Geoscientists began a two-year study of the sediments, coastal zone, and glacio-isostatic tilting of the Lake Winnipeg basin, and found that tilting could explain enhanced shore erosion in the southern part, and that the basin had dried up between 7,000 and 4,000 years ago.

Detailed temperature data were collected from selected inlets along the Atlantic coast of Nova Scotia in support of the growing aquaculture industry. The data were used to define the climate of the inlets, which in turn could be used to determine which species could be cultured, and to determine flushing rates with adjacent continental shelf water.

A project to transfer the Canadian Shelf Climate Database to a more formal relational database management system was completed. The database, consisting of over 425,000 profiles and 9 million observations, was the most comprehensive assembly of temperature and salinity observations available for the Canadian east coast and made it much easier for scientists to extract and analyze the data.

Field observations were conducted of ice pack off the coast of Labrador. Data on ice thickness and type were collected both on the ice and by an airborne electromagnetic ice thickness sensor during three different overpasses of the ERS-1 satellite collecting synthetic aperture radar imagery. These data allowed the development of algorithms to estimate ice thickness and type using satellites. In addition, temperature and salinity profiles of the water column were obtained and used to validate ice-ocean models predicting the formation, movement and decay of the ice pack off Labrador.

An oxygen isotope study was conducted on the summer distribution of sea ice melt-water, river run-off and surface circulation in Foxe Basin, Hudson Bay and Hudson Strait.

Scientists participated in a cruise on the German research vessel RV *Meteor* to repeat hydrographic sections across the Labrador and Irminger Seas as part of the World Ocean Circulation Experiment.

Physical and biological oceanographers collaborated in a program directed at assessing the effects of past, present and future changes in climate on physical and ecological processes on the Scotian Shelf. Studies included a field program to identify and characterize sources of zooplankton and the development of a model based on newly collected and historical data.

As part of the joint Canada/US Global Ocean Ecosystem Dynamics program, a collaborative investigation was undertaken with the Woods Hole Oceanographic Institution and the University of Rhode Island on George's Bank to examine the biological and physical processes affecting recruitment of important species.

The multidisciplinary research program on the fate and effects of drilling wastes on George's Bank continued. Closely coordinated field, laboratory and modelling studies addressed the physical oceanography and sedimentology of George's Bank, the flocculation behaviour of drilling wastes and the sublethal effects of drilling wastes on the sea scallops, the most important commercial species on George's Bank.

In collaboration with the St. Andrews Biological Station, ecologists continued to investigate the environmental impacts of salmon aquaculture in the Fundy Isles area. Three different techniques for measuring benthic changes were evaluated: organic carbon burial rates, benthic enrichment indices and conventional grab sampling.

In preparation for the recovery of the submerged wreck of the *Irving Whale* oil barge off the north coast of Prince Edward Island, snow crabs were analyzed for polychlorinated biphenyls (PCBs) and the results were used as a baseline for assessing any possible release of PCBs during recovery.

The Fishermen and Scientists Research Society, a non-profit partnership between fishermen and fisheries scientists, was established to facilitate communication and conduct collaborative research in support of sustainable marine fisheries.

In collaboration with Dalhousie University and the Institute for Marine Biosciences, a set of molecular DNA markers was developed to examine the population genetics of sea scallops. This new technology was used by scallop hatcheries to determine the parental contribution of different spawning sets, the level of inbreeding in their stock and tracking the yield and growth performance of selected pedigrees.

In collaboration with the fishing industry, a program of sentinel fishing surveys was implemented to obtain information on the status of fish stocks which were no longer being fished commercially because of moratoria. The data collected were compared with those collected on government research surveys.

Fisheries biologists examined length-at-age data which were useful indicators of how well individual fish are doing, and observed that conditions seem to be improving for George’s Bank haddock and some components of northern cod.

Fisheries biologists continued studies of the effects of grey seal predation on eastern Scotian Shelf cod stocks. Samples collected from Sable Island showed that the percentage of cod in the grey seal diet, although variable among samples, had remained at about 15% over a five-year period.

The Virtual Data Centre was created. This web-based data management system quickly became the standard central location for a variety of fisheries survey data with well-documented metadata allowing scientists to access survey and fishery data need for ecological analyses.

Habitat managers implemented a ‘one window’ approach to improve the efficiency of the project review process. This new approach allowed the proponent of a project to submit an application to a single government department that coordinated the exchange of information among different sectors of government and the provinces.

1995

An ocean data inventory system was released that contained all of BIO’s temperature, salinity and current meter data from the waters of eastern Canada. The system allowed users to identify when and where moored time series information was collected, display each record and calculate monthly statistics.

Scientists participated in the US Navy Scientific Ice Experiment program in the Arctic Ocean. Six cruises were made on Sturgeon class nuclear submarines that were able to surface through the ice and establish temporary ice camps, including at the North Pole.

A three-week cruise aboard CSS *Hudson* was conducted to map the broad-scale distribution of phytoplankton, zooplankton and their physical-chemical environment on the Nova Scotian, Newfoundland and southern Labrador shelves, in the Labrador Sea and in the open North Atlantic between Greenland and the Sargasso Sea.

Using satellite ocean colour data, biological oceanographers were able to prepare the first reliable estimates of global marine productivity by phytoplankton.

In cooperation with the Hibernia Management and Development Corporation, a multiyear program was initiated to monitor the fate and effects of drilling wastes at the Hibernia oil field on the Grand Banks. It began with baseline studies conducted just before the gravity-based structure was installed.

A benthic boundary layer sediment transport model named *bblt* was developed and used to predict the distribution and biological effects of operational drilling wastes released from offshore drilling platforms at hypothetical sites in different physical oceanographic zones on George’s Bank.

A new program was established to document the invertebrate bycatch in trawl sets conducted by both research and commercial vessels. The data were entered into the Virtual Data Centre and provided new insight into the spatial distribution of invertebrate bycatch species on the continental shelf.

1996

Hydrographers continued to increase the coverage of electronic navigational charts which were quickly becoming the standard on large commercial vessels in Canada and the world. These charts addressed the requirements of the International Hydrographic Organization and the International Maritime Organization to provide an international standard for marine navigation.

Hydrographic surveys were conducted along the south coast of Newfoundland to obtain modern data for electronic charts and provide a safe navigation corridors between communities. Many locations had never been surveyed or existing data were over 100 years old.

Hydrographers and geologists compiled available bathymetric data from the Atlantic and Arctic regions to determine if it was sufficient to define the outer seabed limits of the Canadian continental shelf over which Canada could have sovereign rights when it ratified the United Nations Convention on the Law of the Sea. It was concluded that further surveys were required.

A methodology was developed to extract and process backscatter data, a proxy for seafloor texture, from multibeam electronic sounding data.

In collaboration with the fishing industry, an extensive multibeam survey was conducted on Brown's Bank. This new technology, similar to removing a blindfold, allowed scientists to see for the first time what the ocean floor really looked like in detail and generated a great deal of enthusiasm among scientists, habitat managers and the fishing industry. Scallop habitat was identified and this information was applied to the management of the scallop fishery.

Geologists initiated studies to understand the processes that transfer waste materials from land to sea in marine environments associated with major urban centres such as Halifax, NS, and Vancouver, BC. Identical methods were used to collect sediment cores and to measure sedimentation rates and metal concentrations. The results provided information that could be used by local agencies to manage effluent discharge.

Geologists examined the impact of Hurricane Hortense and post-storm recovery at several sites along the coast of Nova Scotia. Strong winds combined with high tides produced a storm surge of 1 m and a maximum significant wave height of almost 9 m. This study enhanced emergency preparedness and provided a better understanding of shoreline dynamics and stability.
In collaboration with Mobil Oil Canada Ltd, the hazards to seabed installations for gas production near Sable Island were determined. Innovative seabed instrumentation enabled real-time monitoring of sediment transport during storms. The physics of sediment transport was documented and applied to understanding processes of large-scale bedform migration. These measurements also provided ground truth information for refining models of sediment transport.

Geologists initiated an investigation of shore-zone stability, sediment budgets and coastal response to sea level rise along the north shore of Prince Edward Island to address widespread public concern about coastal sensitivity to climate change. The project included a detailed multibeam bathymetric survey and studies of water and sediment dynamics in Rustico Bay to address coastal management issues dealing with causeway construction, aquaculture development and dredging.

Geologists commenced a major initiative in the Gulf of St. Lawrence to better understand the links between preserved onshore and offshore geological features. The project focused on defining the Maritimes Basin crustal framework, examining onshore-offshore stratigraphic and sedimentological correlations and reviewing what these meant for petroleum systems in the region.

In collaboration with the Cape Breton Development Company and the Canada Centre for Mineral and Energy Technology, repeat multibeam bathymetry surveys were conducted over the undersea coal mines off Cape Breton to determine the annual subsidence of the seafloor over the mine shafts and evaluate the potential hazard of seawater flooding.

In collaboration with the Hibernia Management and Development Company Ltd., geologists assessed how faults act as migration routes into petroleum reservoirs and the potential problems they may pose in the eventual draining of the reservoirs. Another industry collaboration involved development of innovative three-dimensional seismic interpretation techniques to better image subsurface sedimentary basins.

Geologists undertook shore-zone studies in the Beaufort Sea to improve understanding of coastal evolution in ice-rich permafrost terrain as a basis for better prediction of coastal response to changing climate. The high spatial and temporal variance of coastal response demonstrated the need for long-term monitoring at a range of sites as the only viable means to address critical scientific and management issues in the Beaufort Sea region.

Under funding from NATO, geologists prepared a catalogue of seismic refraction data collected by Canada, Norway and Russia in the Arctic. This project enhanced scientific knowledge of the Arctic Ocean and provided information needed for implementation of Article 76 of the Law of the Sea.

Geologists initiated and led a project with over 40 participating organizations from 14 countries to compile magnetic data of the North Atlantic, the Arctic Ocean and their surrounding landmasses. The entire database, merged into one comprehensive digital data set on a CD-ROM, improved understanding of the resource potential of the continental margins of Canada's Arctic and Atlantic coasts.

A Memorandum of Understanding with the South Pacific Applied Geoscience Commission was established to provide cooperation in the geological sciences through scientific exchanges, training, technical assistance and joint investigations on subjects of mutual interest. Two geologists were seconded to Fiji to provide coastal geological expertise for assessing the vulnerability of coastal communities to sea-level rise and other natural hazards including storm surges and cyclones.

BIO staff participated in the successful recovery of the oil barge *Irving Whale* which had sunk north of PEI in 1970.

BIO scientists took part in the Arctic 96 expedition on board the German icebreaker FS *Polarstern* that explored the eastern Eurasian Basin of the Arctic Ocean to address concerns regarding global climate and climate change.

During the Coastal Mixing and Optics Experiment on the continental shelf, the vertical diffusivities of heat and density were obtained using EPSONDE.

In collaboration with the Canadian Meteorological Centre and Dalhousie University, scientists conducted an experiment on the Scotian Shelf to test and improve the forecast skill of CANSARP, the primary planning tool used by the Canadian Coast Guard for search-and-rescue operations.

Two different kinds of helicopter-borne sensors were used to collect pack ice property data from the Canadian east coast to validate ice signatures seen in synthetic aperture radar imagery collected by satellite.

Development continued of accurate ocean forecast models that could be used to simulate seasonal ice distributions and provide short-term ocean forecasts for the Labrador and Newfoundland continental shelves. To demonstrate the operational use of these forecast models, an automated software system integrating the operations of wind data input, numerical calculation and display of forecast results was developed so that daily forecasts of ice and ocean conditions could be generated. Forecasts were put on the Internet to make them accessible to potential users.

A four-year Canadian program was initiated under the umbrella of Global Ocean Ecosystems Dynamics, an international climate research program examining how the abundance, distribution and productivity of marine populations are affected by variability in their environment. This Canadian initiative focused on important zooplankton species and on the early life stages of finfish. Retrospective analyses of historical data and new computer models of shelf circulation evaluated the influences of physical environmental and food-supply changes while new field studies were conducted on the Scotian Shelf.

Surf washing procedures were developed to accelerate the biodegradation rate of oil stranded on beaches and applied to numerous oil spill clean-up situations.

The Halifax Fisheries Research Laboratory was closed and the benthic fisheries programs for lobster, scallops, snow crabs and offshore clams were transferred to BIO.

A three-year study of lobster recruitment and catchability was undertaken in the Gulf of Maine. This included larval drift experiments with satellite-tracked drogues and larval sampling at different locations between George's, Brown's and German Banks and inshore southwest Nova Scotia.

Research on the environmental impacts of Atlantic salmon cage culture continued to focus on defining methods for assessing and regulating the environmental impacts of the industry to help ensure its environmental sustainability. Environmental degradation at many of the sites was being evidenced in chronic parasite and disease problems.

New approaches for quantifying the uncertainty in fish stock assessments were developed and the risk of exceeding fisheries targets were determined. While the current approach focussed solely on uncertainty associated with yearly abundance and did not include variations in other inputs, this important initial step was well received by users of fisheries advice. Knowledge of uncertainty in advice often prompted fisheries managers to select more conservative levels of exploitation.

In cooperation with the fishing industry, fisheries scientists conducted the first stock assessments of the Northwest Atlantic porbeagle, blue and shortfin mako shark populations to help guide the development of the 1997-2000 Atlantic Coast Management Plan, one of only four world-wide existing plans to manage shark resources.

Shellfish biologists worked closely with community groups to promote pollution remediation and enhance the growth of the soft shell clam industry. Remediation activities were successful in reopening 100 hectares of productive clam growing area for commercial harvesting and generated over $300,000 to the local economy.

1997

A team of BIO scientists participated in a cruise of the RV *Knorr* from the Woods Hole Oceanographic Institution to conduct a winter survey of the Labrador Sea. Wind and wave fields were measured to determine the exchanges of momentum, heat and water vapour between ocean and atmosphere under extreme conditions and the effort was rewarded by the direct observation of convection down to depths of 1400 m.

BIO scientists took part in the Joint Ocean Ice Study 97 on board CCGS *Louis S. St- Laurent* in the Canadian Archipelago and the Canada Basin of the Arctic Ocean.

Physical oceanographic measurements were carried out to determine the flushing rates in Country Harbour and Ship Harbour, NS. Currents, temperature and salinity measurements were complimented by seasonal hydrographic surveys, bottom sediment sampling and local meteorological observations.

Scientists created BioChem, a national archive of marine biological and chemical data collected in the Atlantic Zone Monitoring Program and other programs. In 2003, management of this system was taken over by the Marine Environmental Data Service in Ottawa.

A collaborative field experiment on oil spill bioremediation was initiated in collaboration with agencies in France, UK and the Netherlands.

A cost effective shoreline clean-up procedure called 'surf-washing' was developed. Oil stranded in sediment at the high tide mark was mechanically relocated into the surf zone where wave action could stimulate the formation of oil-mineral aggregates and thereby increase the biodegradation of the oil. This technique was validated in field trials in Norway and the UK.

In collaboration with the Northwest Atlantic Fisheries Centre, a three-year experiment was initiated to investigate the impacts of otter trawling on the benthic habitat and communities at an experimental site on Western Bank. Benthic imaging and sampling was conducted by the CCGS *Parizeau* while the CCGS *Wilfred Templeman* and CCGS *Telost* carried out the experimental trawling. This experiment was similar in design to the previous Grand Banks experiment but habitat and communities were much different.

In collaboration with the US National Oceanic and Atmospheric Administration, fisheries scientists conducted the East Coast North America Strategic Assessment Project. Groundfish survey data, collected using standard procedures between Cape Hatteras and the Davis Strait since 1970, were analyzed to describe the assemblages and biogeography of demersal fish along the east coast of North America and observe changes with time.

Scientists served as expert witnesses during the Joint Public Review of the potential impacts of the proposed Sable Island Offshore Energy Project.

Steps were initiated to begin the development of a species recovery plan for the endangered North Atlantic Right Whale. This plan laid the foundation for important achievements toward Right Whale recovery and was used as a model for subsequent recovery plans prepared for other species-at-risk.

1998

A helicopter-mounted video-laser-GPS system was used to collect video images of pack ice in different backscatter regions seen in satellite imagery collected at the Confederation Bridge in Northumberland Strait. The bridge cut the pack ice into small floes as it moved back and forth in response to tidal currents and wind. The position of the ice area affected by the bridge was monitored by satellite-tracked ice beacons.

A thirteen-year program was begun that deployed current meter moorings across Barrow Strait to estimate the volume, freshwater and heat transport through Lancaster Sound into Baffin Bay. The ultimate aim of this program was to determine whether significant changes in the freshwater transport through the Canadian Arctic Archipelago were occurring that would affect oceanographic conditions in the North Atlantic.
In collaboration with US colleagues, refinements continued to be made in the development of numerical circulation models. More highly resolved, three-dimensional models were now able to simulate not only the mean wind- and tidally-induced flows but also density-driven effects associated with upstream sources and local rivers. In the Scotian Shelf and Gulf of Maine region it was now possible to create accurate simulations of the seasonal and inter-decadal variability of the circulation, including the role of the intrusion of Labrador Sea Water in the cold 1960s.

The ECOLOG acoustic fish counting system was used to estimate the abundance of herring stocks. This was the first official use of echo sounding in stock assessment in the Maritime Region.

In collaboration with the Northwest Atlantic Fisheries Centre and Clearwater Fine Foods Ltd., a three-year experiment was initiated to investigate the impacts of hydraulic clam dredging on the benthic habitat and communities at an experimental site on Banquereau. Benthic imaging and sampling was conducted by the CCGS *Hudson* while the MV *Atlantic Pursuit*, a commercial clamming vessel, carried out the experimental dredging.

The Atlantic Zone Monitoring Program was implemented in collaboration with the Gulf, Québec and Newfoundland Regions and incorporated the previously established Labrador Line. The aim was to collect and analyze the physical, chemical and biological field data necessary to characterize oceanic variability at the seasonal, inter-annual, and decadal scales, provide multidisciplinary data sets that could be used to establish relationships among the physical, chemical and biological variables and provide data to support the sound development of ocean activities. Fourteen sections and seven stations were established on the continental shelf between Labrador and George's Bank, including the Gulf of St. Lawrence, for sampling several times a year. The new program complimented other monitoring programs already underway.

The Eastern Scotian Shelf Integrated Management initiative was launched. In contrast to traditional sector-based management that addressed individual industries or activities on a case-by-case basis, the ESSIM planning process considered the ecosystem and all of its users comprehensively and brought regulatory authorities from all levels of government together with a wide array of ocean stakeholders to work collaboratively.

A summer student was hired to begin the development of the BIO Archives.

1999

In partnership with the Nova Scotia Museum of Natural History and the Ecology Action Centre, the Marine Invertebrate Diversity Initiative was created to increase the understanding of marine invertebrates in the waters of the Scotian Shelf, Bay of Fundy and the Gulf of Maine.

The impacts of scallop fishing on benthic communities was examined by comparing epifaunal species in surveys conducted on scallop grounds in the Bay of Fundy in 1966/67 and 1997. The same species were found in both surveys but changes in relative abundance suggested impacts from fishing gear on the larger, more fragile and attached organisms.

A three-year research program involving university collaborators was initiated in Sydney Harbour to study contaminants released over 100 years of steel and coke production and their ecosystem effects.

A two-year research program was initiated in the Gully to increase knowledge of this unique submarine canyon off eastern Nova Scotia that was being considered as a Marine Protected Area.

A comprehensive review of the George's Bank ecosystem and the potential impacts of exploratory drilling was prepared under the Regional Advisory Process. After considering all information, the independent George's Bank Review Panel recommended that the drilling moratorium be extended until 2012.

The Science for the Integrated Management of the Bras d'Or Lakes Project was launched in collaboration with Cape Breton First Nations. It began with a workshop including all stakeholders to develop priorities for scientific research followed by a five-year comprehensive program of physical, chemical, geological and biological oceanography that included training of Eskasoni Fish and Wildlife Commission personnel in oceanographic methods.

A conservation and recovery team was established for the endangered Atlantic whitefish and field and laboratory research was carried out.

2000

Steps were taken to strengthen working relationships with universities, First Nations, other federal and provincial agencies, the private sector, and non-government organizations.
A Canadian consortium, including hydrographers and geologists, was awarded a three-year contract to act as the external scientific consultant for a Geological Survey of Ireland project to map its offshore seabed using multibeam sonar technology. The awarding of this contract underscored Canada's excellent capability in seabed mapping.

Geologists were part of a Canadian consortium in the International Marine Global Change Study investigating climate records from the Scotian Margin and the Labrador Sea that were used in computer models to forecast long-term climate change.

The Canadian Climate Impacts and Adaption Research Network was established and the coastal theme national office was located at BIO.

Geologists signed a five-year agreement with the Uruguayan Department of Defence to exchange marine geoscience information.

In a unique partnership with the Offshore Scallop Producers of Nova Scotia, seafloor-mapping technology was applied to produce digital maps of surface sediments and fisheries habitat on the highly productive scallop grounds of Brown's, George's and German Banks. Five separate layers of information were exported to electronic navigation systems for use by the offshore fishing fleet. This new technology reduced the environmental impacts of dredging and increased the economic benefits for the scallop industry.
Under a partnership with the oil and gas and fishing industries, multibeam bathymetric surveys and follow-up seismic and bottom sampling programs were successfully completed on the Scotian Slope. The project arose out of the need for a regional framework of slope stability for hazard assessment and information for safe exploration. The resulting data set, covering more than 20,000 km^2, represented the largest multibeam bathymetric survey completed in Canadian waters.

Along with other partners, geologists were involved in the creation of a multi-agency program called MARIPROBE that was funded by the Natural Sciences and Engineering Research Council to develop an understanding of the origin and evolution of Canada's extensive and resource-rich continental margins.

In partnership with the Pictou Harbour Environmental Protection Project under the Atlantic Coastal Action Program, geologists conducted a detailed aerial video survey along the Northumberland Strait for mapping the physical character of the shoreline and monitoring natural and human-induced changes.

Scientists led the development of an interdepartmental proposal for a national seabed resource mapping program called SeaMap that was intended to map the entire seafloor using multibeam technology within Canada's Exclusive Economic Zone off all three coasts. Planning workshops were conducted across Canada and attended by representatives from federal departments, ocean user industries, ocean mapping firms, other service industries, provincial government departments, universities, non-government organizations and environmental groups. While approved by Cabinet, SeaMap was never funded.

The Government of Canada continued its special funding for projects on climate change under the Climate Change Action Fund. One of the BIO projects focused on the potential impacts of sea level rise on the coastal regions of Atlantic Canada.

Following the sinking of the Russian nuclear-powered submarine *Kursk* in the Barents Sea, a Canadian-Russian program analyzed seawater, sediment and organisms near the wreck to assess the ecosystem impacts on this productive fishing area.

In collaboration with Dalhousie University, the Centre for Marine Environmental Prediction was created to provide oceanographic data products from ocean and atmospheric monitoring programs to ocean industries and society.

In response to concerns raised by some sectors of the fishing industry and environmental organizations, a long-term program was initiated to investigate the occurrence, distribution and ecology of deep-water corals off Atlantic Canada. Study sites visited by CCGS *Hudson* were selected using the results of recent multibeam surveys as well as traditional ecological knowledge.

The three-year Environmental Studies for Sustainable Aquaculture program was launched to expand research on aquaculture-environmental applications. Field studies were conducted at salmon pen aquaculture sites in southwestern New Brunswick, Bay d'Espoir, NL, and Broughton Archipelago, BC. Physical circulation models were developed which provided a framework for estimating the dispersion of dissolved and particulate wastes.

The Aquaculture Collaborative Research and Development Program was initiated with industry partners providing 30% of the funding. This program supported studies of mussel-environment interactions to develop physical models describing water exchange in Prince Edward Island inlets where intensive mussel aquaculture was established.

The Centre for Marine Biodiversity was established in partnership with Dalhousie University, the Huntsman Marine Science Centre and other agencies.

The Canadian Lobster Atlantic Wide Studies program was initiated to monitor stock status and improve conservation measures.

Under the Canadian Biotechnology Strategy, a joint project with the University of Prince Edward Island, the University of New Brunswick and Dalhousie University was initiated to study the population genetics of lobster, herring and haddock. In addition, a Memorandum of

Understanding was signed with Dalhousie University to facilitate collaboration on research on marine conservation genetics.

The Oceans Act continued to influence BIO's programs. A key component of the new oceans management strategy was the development of oceans management plans within which the aggregate activities of ocean use would achieve broad conservation objectives. BIO scientists led the preparation of a framework for the practical application of ecosystem-based management which was accepted as a national model.

The program of the newly established Aquaculture Coordination Office focussed on implementing improvements to the regulatory framework and the site approval process, updating the framework for operational decision-making to ensure front-line staff have the direction and the information they need to make sound and consistent decisions and working with the provinces and industry to establish mechanisms for cooperation and harmonization.

A Memorandum of Understanding was signed with the First Nations in the Bras d'Or Lakes area of Cape Breton to enhance research in support of integrated management of this unique marine ecosystem. Fieldwork focussed on habitat mapping, using multibeam sonar and LIDAR, and measurement of water circulation and mixing.

In preparation for an enhanced focus on marine endangered species, the Marine Aquatic Species at Risk Office was established. Species of interest included the northern right whale, leatherback turtles, harbour porpoise, Atlantic whitefish and inner Bay of Fundy Atlantic salmon.

In partnership with the World Wildlife Fund, a recovery plan for the northern right whale, one of the endangered species of concern, was prepared. In collaboration with East Coast Ecosystems, surveys were carried out of right whale distribution in the summer feeding area off southwest Nova Scotia.
In collaboration with other local partners, a third one-day synoptic survey of water quality in 50 Metro area lakes was conducted using a helicopter to collect samples.

Efforts continued to protect remaining salmon stocks in Atlantic Canada. Management options being considered included liming rivers to neutralize acidity, stocking with hatchery-raised smolts, live gene banking for future restoration and restricting exploitation.

2001

BIO played a leadership role in the federal science and technology community by initiating the Hypatia Project that was designed to identify and develop a strategy to reduce the factors limiting the recruitment, participation and retention of women in science and technology positions. The mandate of the project included improving organizational health, increasing awareness of the benefits that diversity brings to creativity in science and technology and developing a workplace that actively supports diversity.

A memorandum of Understanding with the Canada-Nova Scotia Offshore Petroleum Board was signed to facilitate the sound management of petroleum activities for protecting the marine environment.

The Canadian Hydrographic Service obtained national ISO 9001-2000 certification from the International Organization for Standardization, an achievement resulting from more than two years of effort to meet stringent requirements.

Electronic chart coverage for all major harbours and routes on the east coast was completed. Production of traditional products continued with the publication of new paper charts and new editions of old charts. Progress was made in updating older charts to modern standards. Critical computer hardware and software were upgraded and the electronic data storage system at BIO was improved.

In response to increased drilling activity in the Beaufort Sea, research on seabed geohazards continued and included studies of ice scouring, permafrost, gas hydrates, seabed foundation conditions, artificial islands and submarine landslides.

Physical oceanographers became involved with the international Argo Program, the largest ocean climate monitoring system in the world. Temperature and salinity profiles from 2000 m to the sea surface were collected using an array of free-drifting ALACE floats and relayed by satellite to shore stations. These data provided valuable information on changes to the Earth's climate and hydrological cycle. BIO scientists launched 340 ALACE profiling floats in the North Atlantic, an important contribution to the 3000 floats launched worldwide.

Biological oceanographers developed a scheme for partitioning the world ocean into biogeochemical domains and provinces based on phytoplankton growth dynamics and the underlying physical forcings.

The rapid expansion of mussel aquaculture was of increasing concern and a three-year study of aquaculture ecosystem interactions was begun in collaboration with numerous scientists in the Maritimes, Gulf and Quebec Regions. Field work was conducted in several coastal inlets in Prince Edward Island and Quebec, with a focus on Tracadie Bay. This was one of the first multidisciplinary studies of the effects of shellfish aquaculture at the coastal ecosystem scale.

In collaboration with the fishing industry, fisheries scientists surgically implanted acoustic transmitters in 200 inshore cod and deployed an array of acoustic receivers along 160 km of the seafloor off Cape Breton to follow their movement. The aim of the study was to evaluate the degree of mixing of inshore Cape Breton cod stocks with the Gulf of St. Lawrence cod.

In collaboration with the Northwest Atlantic Fisheries Centre, benthic ecologists, fisheries biologists, engineers and geologists initiated a five-year program to study the spatial utilization of benthic habitat by demersal fish at six sites on Emerald, Western and Sable Island Banks. A wide variety of acoustic, imaging and sampling methods was used to observe fish, benthic organisms and benthic habitat using the CCGS *Hudson.* The CCGS *Alfred W. Needer* collected samples of fish by otter trawling for analysis of species, size and stomach contents. An extensive database was collected which provided a unique opportunity to examine the detailed relationships between demersal fish and their physical habitat.

DFO fish hatcheries in Mactaquac, NB, Coldbrook, NS, and Mersey, NS, became biodiversity facilities and worked to develop and maintain living gene banks for Atlantic salmon.

Under the auspices of the Regional Advisory Process, a three-phase approach was initiated to determine how the increasing impacts of human activities on benthic habitat should be managed. Phase 1 involved examination of different systems for classifying benthic habitat which led to the selection of a classification system which categorized habitat according to its exposure to physical disturbance and physiological stressors.

2002

In preparation for the upcoming 50th anniversary of BIO, a history project was begun to record the recollections of early staff, capture the flavour of the BIO experience and document contributions to science and Canadian society. Interviews were transcribed and placed in the BIO Archives.

In collaboration with the University of New Brunswick, a seven-year systematic multibeam sonar bathymetric survey of the Bay of Fundy was initiated that employed the CCGS *Frederick G. Creed*, the CCGS *Matthew* and several survey launches. The high tidal range and dearth of adequate port facilities presented practical challenges that had to be overcome.

Scientists participated in a major international expedition to the Greenland Sea on board the Swedish icebreaker IB *Oden* as part of a two-ship study of deep-water mass formation.

A new study was initiated to collect multiyear data with moored instruments in the Labrador Current and Flemish Pass off the northeast Grand Banks.

The Centre for Offshore Oil, Gas and Energy Research (COOGER) was established as a virtual centre, based at BIO, that pulled together scientists from across the country to tackle environmental issues related to the energy sector in the ocean.

The Oyster Experimental Project was undertaken in the Bras d'Or Lakes to better understand how to manage the MSX oyster disease. This disease, caused by a microscopic parasite, did not have public health concerns but had the potential to negatively affect oyster populations.

A project was initiated to create a detailed atlas of fish-spawning areas on the Scotian Shelf that could be used in managing hydrocarbon exploration activity.

A new fisheries assessment procedure termed the Traffic Light Approach was developed for little known and data-poor stocks. It tabulated indices of stock recruitment, growth, mortality and ecosystem trends using a wide range of data sources. It was subsequently applied to a number of groundfish and invertebrate assessments.

A new Aquaculture Policy Framework was implemented to provide a common vision for marine and freshwater aquaculture in Canada.

The Honourable Robert G. Thibault and the Honourable Ernest Fage signed a renewed Canada/Nova Scotia Memorandum of Understanding on aquaculture development that enabled both the federal and provincial governments to continue working together on the environmental management of the aquaculture industry in Nova Scotia.

In collaboration with the Institute of Marine Biosciences, the St. Andrews Biological Station and the Gulf Fisheries Centre, a Memorandum of Understanding was signed to enhance collaborative research on aquaculture and biotechnology.

A new mobile microbiology laboratory was obtained and used throughout the Maritime Provinces to sample the water quality at aquaculture and shellfish harvesting sites.

After considerable consultation with the fishing industry and environmental organizations, a 424 km^2 conservation area was created in the Northeast Channel that was closed to fishing activities to protect the abundant deep-water corals.

2003

Canada ratified the United Nations Convention on the Law of the Sea (UNCLOS) and had ten 10 years to provide evidence to support the establishment of the outer limit of Canadian jurisdiction.

Scientists participated in an interdepartmental initiative to develop a Federal Climate Change Science Plan to lay out an integrated approach for all federal departments and agencies involved in climate change science to ensure that the Canadian Government has the knowledge and tools needed to make informed policy and program decisions on climate change actions.

Hydrographers initiated the three-year Remote Sensing Shoreline for Northern Labrador project to address the serious lack of up-to-date coastal information on nautical charts, particularly north of Nain.

A joint program was initiated with Environment Canada, the National Research Council, Defence Research and Development Canada, and Dalhousie and McGill Universities to collect and analyze offshore wind and wave data during extra-tropical storms in order to help improve weather forecasting.

In collaboration with Dalhousie University and Environment Canada, a three-year project on Interdisciplinary Marine Environmental Prediction in the Atlantic Coastal Region was initiated which was funded through the Canadian Foundation for Climate and Atmospheric Sciences. The project involved an atmosphere-ocean observing system in Lunenburg Bay and the development of predictive models for the atmosphere, ocean circulation, biology and waves.

In a joint initiative with Environment Canada, partly funded by the Canadian Space Agency, methodologies were developed for estimating marine wind fields from two types of satellite radar data for use in validating numerical weather prediction models.

Scientists participated in an international initiative led by the Group on Earth Observation Systems to develop a global observing system. Their primary contributions were determining the appropriate scales and accuracies of ocean measurements required for the management of marine ecosystems, the prevention or mitigation of marine hazards and disasters and the monitoring of ocean climate.

Under the Geoconnections Program, an integrated taxonomic information system was developed that provided an authoritative species list for trawl survey and ichthyoplankton data sets. The system was useful in validating scientific names against internationally accepted standards and providing full taxonomic hierarchies.

An Electronic Atlas for Ichthyoplankton on the Scotian Shelf of North America was developed that contained information on location and time of spawning and the abundance and distribution of eggs and larvae of marine fish. It was intended for use in environmental assessment and management activities associated with offshore hydrocarbon development and ocean management.

In collaboration with the fishing industry, a study was started to improve understanding of the biology, movements, and population health of the spiney dogfish.
The first observed reef-complex of the deepwater coral *Lophelia pertusa* in North America was discovered by the CSS *Hudson* at the Stone Fence in the Laurentian Channel while Halifax was being hammered by Hurricane Juan.

In partnership with other agencies, an outdoor experimental wave tank facility was built to investigate the influence of wave energy on the efficacy of chemical oil dispersants.

In collaboration with the Nova Scotia Department of Energy, Petroleum Research Atlantic Canada and Marathon Canada, a program was initiated to investigate the impacts of sound from seismic surveys on the behaviour of marine mammals. A related project with Corridor Resources Inc. investigated seismic impacts on snow crabs off the west coast of Cape Breton. A Memorandum of Understanding was signed with the Nova Scotia Department of Energy to formalize collaboration in acoustic monitoring and marine mammal observations in The Gully and outer Scotian Shelf before and during seismic surveys. The objective of the study was to learn more about the behaviour of, and impact on, marine mammals of sound from seismic surveys.

Ecologists contributed to the development of a comprehensive report that synthesized two decades of research on the capacity constraints for salmon cage culture in the Bay of Fundy and provided guidance to regulators and the aquaculture industry.

An inner Bay of Fundy recovery team for Atlantic salmon was established. Research focussed on the Stewiacke and Big Salmon Rivers and included developing live gene banks.

An ecosystem status report of the eastern Scotian Shelf documenting long-term changes was prepared for oceans and fisheries managers. Trophic changes due to the removal of large fish were observed, in particular increased abundance of small pelagic species such as herring and benthic invertebrates such as snow crabs.

The Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic project was initiated which included ecosystem modelling of the Scotian Shelf in order to gain a better understanding of the structure and function of eastern Canadian marine ecosystems.
In collaboration with DFO Aboriginal Affairs, the Aboriginal Aquatic Resource and Oceans Management program was developed to assist aboriginal groups acquire the capacity to successfully manage their resource activities in the Bras d'Or Lakes watershed.

A major report entitled *The State of the Ecosystem for the Eastern Scotian Shelf* was prepared that provided a synthesis of oceanographic, ecological and ocean use trends over several decades that could be used in the development of an integrated management plan to harmonize different ocean uses such as fishing, oil and gas development and transportation.

Scientists contributed to the development of the *Three Oceans of Biodiversity, A Canadian National Plan 2004-2009* that provided guidance on inventory, monitoring and research on marine biodiversity in support of Canada's commitment to the UN Convention on Biological Diversity.

Efforts continued to work with the provinces to improve the marine aquaculture site review process with the goal of harmonizing information requirements and eliminating duplication of review requirements at both levels of government.

A revised routing plan for vessels entering the Bay of Fundy was established to reduce collisions with the endangered North American right whale.

BIO Library staff initiated a project to create an online bibliography of all publications and digitize all reports.

2004

DND staff embarked in HMCS *Shawinigan* for an exercise off Norfolk, VA, to collect and process data in support of mine warfare. They were also deployed to Lake Ontario to survey an area near Kingston in search of models from the AVRO Arrow project of the 1950s. No models were found but a 31-metre schooner sitting upright on the seabed was located.

Hydrographers and geologists made plans to collect the additional seismic and bathymetric data that were required to conclusively define the outer limits of Canada's continental shelf off the Atlantic and Arctic coasts under Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS).

As part of the Oceans Action Plan, hydrographers and geologists undertook an expanded seabed mapping program to increase scientific understanding of the physical environment and associated habitats in support of integrated management planning and the identification of marine areas in need of protection.

As part of the global humanitarian response to the catastrophic tsunami off Indonesia, geologists provided technical and scientific assistance on early warning systems and coastal erosion.

An interregional, interdepartmental group of scientists from DFO, Environment Canada, National Defence and academia developed a national environmental forecast system to provide a foundation for integrated ocean management and the safe and efficient use of Canada's oceans. It was anticipated that the final, fully validated coupled ocean-ice-atmosphere forecast system would be linked to global data streams produced by the Canadian Group on Earth Observation Systems.

The field phase of a moored-measurement program for measuring currents and water mass variability on the Halifax Section across the Scotian Slope was completed. Current meter moorings were successfully recovered from three sites, providing multiyear time series going back to 2000. A similar program was initiated to study currents and water mass variability in Orphan Basin on the northeast Newfoundland Slope with moorings deployed at five sites.

The high performance computing Linux cluster Beowulf was acquired and provided the additional computing power needed for the development and validation of numerical ecosystem models.

Experiments began with the new oil spill-dispersant wave tank to develop guidelines for the use of oil dispersants.

In collaboration with industry and academic partners, a seismic research program was conducted in The Gully to investigate the potential impacts of sound on marine mammals, including the northern bottlenose whale, a species at risk. The project provided essential data to validate and improve sound propagation models used in environmental assessments.

The first comprehensive analyses of the status of blue and shortfin mako sharks was prepared as part of international effort coordinated by the International Commission for the Conservation of Atlantic Tunas to determine the population health of large sharks in the North Atlantic.

Fisheries biologists launched a comparative fishing program to compare the performance of the three research trawlers operating in the Atlantic Region (CCGS *Templeman*, CCGS *Teleost* and CCGS *Alfred W. Needler*). The results were used to determine the interchangeability of vessels and data within the region.

A new program was established to investigate the life history, egg production, moult cycles, growth, migration, habitat requirements and assessment methodology of snow crabs on the Scotian Shelf.

Ocean Biogeographic Information System (OBIS) Canada was developed as the Canadian node for the international OBIS program and as the information component of the international Census of Marine Life Program. OBIS made marine biogeographic data from all over the world freely available on the Internet.

Under the auspices of the Regional Advisory Process, two workshops were held to address Phase 2 of the benthic habitat classification project. At the first, a classification of the benthic communities of the Scotian Shelf based on the Southwood model was presented and discussed. This approach integrated information on geology, oceanography and benthic ecology. The second workshop further explored the concepts and application of the model to the Scotian Shelf.

The Gully was proclaimed Canada's first Marine Protected Area in the Atlantic Region to conserve and protect its unique natural biological diversity, including the at-risk northern bottlenose whale.

After consultations with the fishing industry, fisheries managers and environmental organizations, a 15 km^2 Coral Conservation Area was created at Stone Fence in the Laurentian Channel to protect the newly discovered *Lophelia* reef complex from further damage by bottom-impacting fishing gear.

2005

An office was established to support the preparation of the necessary technical material for Canada's submission to establish the limits of continental shelf jurisdiction off the Atlantic and Arctic coasts under Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS). This UNCLOS Program Office was headed by the Director, Canadian Hydrographic Service (Atlantic) and the Director, Geological Survey of Canada (Atlantic). Additional bathymetric and seismic surveys were begun.

DND staff were instrumental in the recovery of a Canadian Coast Guard helicopter that crashed into the sea off Newfoundland and Labrador.

Scientists participated in the international trans-Arctic Beringia expedition on the Swedish icebreaker IB *Oden* that made oceanographic measurements on a section from the Barents Sea through the North Pole and across the little-sampled Canada Basin to Alaska. This was the first crossing of the Arctic Ocean by a modern oceanographic vessel.
Proposals were prepared for Canadian International Polar Year funding which included modelling work on wave erosion in the Beaufort Sea, ocean-ice modelling and mooring work in the Canadian Archipelago and Davis Strait, and arctic and sub-arctic ship surveys for chemical tracer and plankton ecosystem studies.

The Centre for Ocean Model Development and Application was created involving participants from across the country. The two initial projects undertaken were developing an operational, global coupled atmosphere-ice-ocean assimilation and prediction capability for Canada and developing and applying ocean hindcast, nowcast and forecast models as part of a national operational oceanography system for Canada.

The Discovery Corridor Program was created in collaboration with the St. Andrews Biological Station, the Atlantic Reference Centre, the Gulf of Maine Census of Marine Life, Dalhousie University and Memorial University. The goals were to compile an inventory of species along a transect running from the Fundy Isles across the Gulf of Maine out to depths of 6000 m, and to develop projects to understand how conservation of marine biodiversity could be accommodated along with sustainable utilization of marine resources.

Fisheries biologists initiated a new program on the migration pathways of sharks using technological advances in satellite tracking. Archival satellite pop-up tags were used to track the depth, water temperature, and approximate location of individual porbeagle and blue sharks for periods of up to a year.

The draft Eastern Scotian Shelf Integrated Management Plan was prepared and released for public review.

An atlas was prepared of human uses of the Scotian Shelf including fishing, shipping and oil and gas development.

A project was carried out to examine the effectiveness of reef balls as an option for habitat compensation. Reef balls were artificial structures made with concrete designed to replace damaged benthic habitat. Field trials were conducted in Halifax Harbour and St. Margaret's Bay. This project led to other more comprehensive laboratory and field experiments to closely examine the relationship between habitat architecture and macroinvertebrate shelter behaviour.

2006

A BIO-built seismic system was tested in ice conditions in the Canada Basin in the Arctic Ocean on CCGS *Louis S. St-Laurent* in preparation for UNCLOS surveys.

Canadian and Danish scientists participated in the Lomonosov Ridge Test of Appurtenance project in the Arctic Ocean, a seismic and hydrographic on-ice survey based at the Canadian Forces Base at Alert, Nunavut. The purpose was to collect data to show geological continuity between the Lomonosov Ridge and the North American continent for the United Nations Convention on the Law of the Sea (UNCLOS) submissions.
The UNCLOS Program Office conducted a contract multibeam survey on the Grand Banks that mapped the 2500 m isobath and profiles across the foot of the slope area on 30-nmile spacing.

A three-year seabed mapping project, conducted in collaboration with the fishing industry, was completed in Scallop Fishing Area 29 in southwest Nova Scotia. Maps of high-resolution multibeam bathymetry, acoustic backscatter strength and surficial geology were produced. Benthic data, collected using photographic and video equipment, were used to determine the distribution of benthic assemblages in relation to bottom type.

As part of the Atlantic Zone Monitoring Program (AZMP), the Scotian Slope/Rise Monitoring Program was created by adding stations to the seaward end of the Halifax Section. Physical, chemical and biological data were collected at least once annually at the deep-water stations. The sampling protocol was the same as the Labrador Sea Monitoring Program.

In collaboration with Boston College, a study of fluid mud in the Petitcodiac River, NB, was undertaken with the goal to understand how fluid mud forms and affects the movement of water and sediment in regions with large tides and high sediment loads. This information was used to predict the response of the Petitcodiac River to possible changes in the operation of the Moncton causeway constructed in 1970.

The geographic scope of integrated management planning was extended to include the inshore waters of the Scotian Shelf, critical nursery and feeding areas for many marine species. The Inshore Ecosystem Research Project, a joint project with the Fishermen and Scientists Research Society, was initiated to determine the distribution and relative abundance of all species caught by commercial fishing gear. In addition, fishermen's knowledge of the Scotian Shelf ecosystem was mapped through a Traditional Ecological Knowledge survey.

The Musquash Estuary in New Bunswick became the second Marine Protected Area in Atlantic Canada.

2007

The UNCLOS Program Office participated in a Danish-Swedish-Canadian seismic and hydrographic survey of the Lomonosov Ridge using the Swedish icebreaker IB *Oden*, supported by the Russian nuclear icebreaker *50 Led Poteby*.

The UNCLOS Program Office conducted a seismic and hydrographic survey in the Canada Basin of the Arctic Ocean on board the CCGS *Louis S. St-Laurent* to determine the foot of the slope and the thickness of sediments.

The UNCLOS Program Office conducted a $5.2 million contract seismic survey off the Scotian Shelf.

Geologists collaborated with the Lake Simcoe and Nottawasaga Conservation Authority and University of Rhode Island and discovered evidence of groundwater input to the lake.

In collaboration with the US, a five-year regional Ecosystem Research Initiatives project was initiated to advance the science foundation of ecosystem-based management in the Gulf of Maine/Bay of Fundy area. The work addressed the influence of climate change on oceanography and ecosystems, the spatial patterns in benthic communities and the impact of ecosystem interactions on harvest strategies and species dynamics.

A new research program was initiated to address some of the questions raised in a strategic environmental assessment commissioned by the Nova Scotia Department of Energy on tidal energy development in the Bay of Fundy using Tidal In-Stream Energy Converters (TISECs). This program, conducted in collaboration with universities, included investigations of tidal energy, current and sedimentological issues, development of a new sediment transport model and development of acoustic methods for studying the behaviour of fish and mammals in the vicinity of active TISEC devices.

The Science for Integrated Management of the Bras d'Or Lakes program, conducted in collaboration with Cape Breton First Nations communities, was completed. It filled many gaps in the knowledge of the Bras d'Or Lakes ecosystem. Highlights included an ecosystem study designed to permit a comparison between the Bras d'Or Lakes and nearby continental shelf ecosystems, a mapping project to delineate sensitive habitats and help plan future sampling programs and a mooring array to provide information on physical, chemical and biological processes during the winter and early spring.

In response to a United Nations General Assembly resolution, a major new program was established to identify vulnerable marine ecosystems and take steps to protect them from disruptive fishing practices. The initial work focused on benthic ecosystems outside the Canadian economic zone under the regulation of the North Atlantic Fisheries Organization.

After many years of development, the Eastern Scotian Shelf Integrated Management Plan was released.

2008

The UNCLOS Program Office conducted an on-ice seismic and hydrographic survey on Alpha Ridge. The Alpha Ridge Test of Appurtenance project was staged from Eureka, Nunavut, and an ice camp on the Arctic Ocean. Defence Research and Development Canada participated in an experiment to extend the length of the seismic line by dropping hydrophones from an Aurora aircraft that recorded the arrival of the echo from each detonation of the charges.

The UNCLOS Program Office conducted a joint Canada-US seismic and hydrographic survey in the Canada Basin using the CCGS *Louis S. St-Laurent* and USCGC *Healy*. Where seismic was the priority, the USCGC *Healy* broke ice for the CCGS *Louis S. St-Laurent* and where bathymetry was the priority the roles were reversed. The planned profiles were 50 nmiles apart to allow for zigzagging to get through the ice and meet the UNCLOS requirements of a foot of the slope point every 60 nmiles.

In partnership with the Proudman Oceanographic Laboratory, UK, a project was initiated under the international Rapid Climate Change program. Current meter moorings were deployed in the Deep Western Boundary Current along the Scotian Rise off Halifax and the observations were used to describe variability in the ocean climate off Atlantic Canada and in the North Atlantic's meridional overturning circulation, an important component of the global climate system.

Under the International Governance Strategy, a project was initiated to provide an oceanographic characterization of seamounts and other ocean areas being considered for precautionary closure to fisheries because of their potential ecological vulnerability. The field program began with the collection and analysis of data from Orphan Knoll, a continental fragment 550 km northeast of Newfoundland.

In collaboration with Dalhousie University and with funding from the Canadian Foundation for Innovation, the Ocean Tracking Network was established. This network was an array of bottom-mounted hydrophones for the detection of acoustic tags that had been surgically implanted into individuals of various species of marine fish and mammals. By comparing data from different areas, critical migration patterns, queues and timings were deduced and used to improve understand the marine ecosystem and manage important fisheries or threatened species.

The Program for Aquaculture Regulatory Research was established to develop new knowledge to support and advise ecosystem-based environmental regulations and decision making related to aquaculture. This program included an assessment of the environmental impacts of mussel aquaculture in St. Ann's Harbour, NS, the largest mussel lease approved in the Maritimes.

The Social, Economic, Cultural Overview and Assessment Report for the entire Scotian Shelf was produced and distributed to federal and provincial partners on CD.

2009

The UNCLOS Program Office conducted a joint Canada-Denmark hydrographic survey consisting of through-ice sounding profiles on the Alpha and Lomonosov Ridges from an ice camp at Ward Hunt ice shelf.

The UNCLOS Program Office continued joint Canada-US seismic and hydrographic surveys in the Canada Basin using the CCGS *Louis S. St-Laurent* and USCGC *Healy*.

The UNCLOS Program Office participated in the Danish-Swedish-Canadian seismic and hydrographic survey in the Arctic Ocean on the Swedish icebreaker IB *Oden*. This survey operated primarily in the Amundsen Basin but did cross the Lomonosov Ridge and enter Makarov Basin near the North Pole and collected data over Nautilus Spur.

The UNCLOS Program Office conducted seismic surveys in the Labrador Sea using CCGS *Hudson.*

The Geoscience for Ocean Management Program was successfully completed. It delivered geoscience knowledge to make informed decisions regarding Canada’s offshore lands and produced extensive seabed mapping in priority areas identified in Canada’s Oceans Action Plan. This program was succeeded by the Offshore Geoscience Program which was planned to facilitate economic development through assessment of hydrocarbon resources, identification of development constraints and provision of geoscience information to other government departments.

High-resolution ocean-mapping imagery collected by geologists revealed a large submarine slide complex on the flanks of the Notre Dame Channel off Newfoundland. This discovery was of great interest because it was previously believed that such large failures were confined to the upper continental slope and fjords. Slides of this magnitude would be capable of creating highly destructive tsunamis, but the Notre Dame Channel features were deemed to be of ice age glacio-tectonic origin.

As part of the international Census of Marine Life program, the international Natural Geography In-Shore Areas program was initiated in collaboration with the Huntsman Marine Science Centre, the St. Andrews Biological Station and the Gulf Fisheries Centre to quantify the biodiversity of benthic flora and fauna in coastal habitats throughout the world. Regional seagrass and rocky shore study sites were sampled using a standard protocol to ensure comparability of data across all regions and food network models were developed.

BIO scientists led a third assessment of the George’s Bank drilling issue that this time included the risks associated with potential hydrocarbon production activities. Shortly after, the Governments of Nova Scotia and Canada extended the drilling moratorium until 2015.

The marine water quality monitoring program, which measures bacterial conditions in shellfish growing areas, received ISO accreditation, an international standard of excellence.

2010

The UNCLOS Program Office conducted a winter hydrographic survey in the Arctic Ocean from a base near Borden Island. This survey used helicopters to collect through ice soundings and an International Submarine Engineering Explorer 5000 Autonomous Underwater Vehicle (AUV). The AUV was heavily supported by Defence Research and Development Canada and was deployed at Borden Island, rendezvoused at an ice camp for recharging, collected bathymetric data in the Sever Spur area and returned to Borden Island successfully, a total distance of over 800 km.

The UNCLOS Program Office continued joint Canada-US surveys in the Canada Basin using the CCGS *Louis S. St-Laurent* and USCGC *Healy*.

Analysis of data in the BioChem database revealed a trend of increasing acidity in surface water on the Scotian Shelf between 1924 and 2006 reflecting increasing concentrations of carbon dioxide in the atmosphere from burning fossil fuels.

At the request of the US Environmental Protection Agency, scientists participated in the oil spill response operations associated with the *Deepwater Horizon* blowout in the Gulf of Mexico, the largest accidental oil well blowout in the history of the petroleum industry. Chemical oil dispersants were injected at the wellhead using a remotely operated vehicle and the plume of subsurface oil was tracked over a four-month period.

2011

The UNCLOS Program Office completed the joint Canada-US seismic and bathymetric survey program in the Arctic Ocean using the CCGS *Louis S. St-Laurent* and USCGC *Healy*. Data were collected along a line from the Beaufort Sea to the Chukchi Ridge, across the Alpha Ridge, over the Makarov Basin, across the Lomonosov Ridge and back across the Alpha Ridge and Sever Spur. An autonomous underwater vehicle was deployed from the CCGS *Louis S. St-Laurent* collect bathymetric data in the Sever Spur area.

A prototype real-time data system was installed in Barrow Strait. Data collected included ice drift, currents, acoustic backscatter (zooplankton), temperature and salinity and were transmitted to BIO by satellite.

In collaboration with other local partners, a fourth one-day synoptic survey of water quality in 50 Metro area lakes was conducted using a helicopter to collect samples.

2012

The UNCLOS Program Office conducted a joint Canada-US project to collect multibeam bathymetric data south of Nova Scotia using the Woods Hole Oceanographic Institute vessel RV

Atlantis. This survey brought the planned data collection for the Atlantic Ocean under the UNCLOS project to an end.

CRYSTAL AWARDS

Some highlights of BIO research programs are also illustrated by the Crystal Awards that were presented on the occasion of the fiftieth anniversary of BIO in 2012 to recognize outstanding and innovative accomplishments of scientific and technical research teams. These are listed below by decade. More details are provided in the permanent display just inside the main entrance of BIO.

1962-1972

BIODAL and GEODAL

BIODAL and GEODAL are data acquisition systems, designed and built at BIO, for recording key ship's parameters. These digital data logging systems were created in a pre-integrated circuit, pre-microprocessor era and thus posed a major engineering design challenge. They enabled sea-going researchers to reliably record vast amounts of marine data for over a decade. This significantly contributed to an improved understanding of the geology, physical and chemical oceanography and marine biology of our oceans.

Hudson 70 Expedition

This epic voyage, conceived and implemented by BIO, would become the greatest single effort that Canada has made in oceanographic research. It involved a collaborative effort of over 100 scientists, technicians, ship's crew and BIO staff. Outstanding scientific contributions were made over 11 months, in four oceans as *CSS Hudson* achieved the first circumnavigation of North and South America.

Hydrostatic Rock Core Drill

The hydrostatic rock core drill is an innovative sampling tool powered by hydrostatic pressure that was used successfully to collect rock core samples from the seabed in water depths as deep as 1600 metres. Canadian deep sea marine geology research during the middle and late 1960's created a need for a more precise hard rock core sampling capability that catalyzed the development of the BIO deep sea hydrostatic drill (DSHD). The development team overcame a number of significant engineering and technical challenges in the development of this unique marine sampling device. It was successful in collecting hard rock cores at several submarine mountaintop and median valley settings on the Mid-Atlantic Ridge at 45 degrees north latitude, a feat never before achieved.

1972-1982

St. George's Bay Program

This research initiative focused on the study of the interaction of physical, chemical and biological factors controlling the dynamics of the growth and survival of larval mackerel and lobster. Techniques and equipment developed here were used for later studies, both regionally and internationally.

Operation Oil
This project was aimed at resolving a series of complex scientific and technical problems arising from the 1970 Arrow bunker C oil spill on 4 February, 1970, in Chedabucto Bay, NS. The BIO-based task force formed by Dr. William Ford dealt with a myriad of demanding and urgent requests from the task force commander Patrick McTaggart-Cowan. This project assembled one of the largest and most comprehensive multi-agency teams in the 50-year history of the Bedford Institute.

BATFISH
BATFISH is an undulating towed instrument designed to carry various oceanographic sensors used for physical and biological oceanographic studies. It was a very innovative design for the 1960's, a time when the sensors, computers, and navigation systems were all somewhat less than adequate to meet demands. During the following thirty years this towed platform was used extensively at BIO for physical and biological oceanographic studies and a number of units were sold internationally.

Development of Ocean Bottom Seismometers
Seismic refraction studies at BIO were undertaken to reveal the nature and geometry of the Earth's crust in Canada's offshore regions. This research was greatly facilitated by the development of Ocean Bottom Seismometers (OBS) designed by a team of scientists and engineers at BIO. An OBS records seismic waves on the seabed and upon release the OBS floats to the surface for retrieval. On the seafloor, they detect shear and compressional waves in an acoustically quiet environment, a vast improvement over sea-surface sonobuoys that had been used previously. The OBS has been widely used nationally, in all three of Canada's oceans, and as part of Canada's contributions to international seismic projects.

Electric Rock Core Drill
The electric rock core drill was developed by engineers and technologists at BIO. Through the application of innovative engineering design concepts, the design team persevered to create a bedrock-sampling device that was unique in its time. It enabled marine scientists throughout the world to collect samples that contributed significantly and directly to the mapping and understanding of shallow seafloor bedrock geology.

Mapping of the Surficial Sediments of Offshore Eastern Canada
The surficial sediment mapping project of the southeast Canadian Continental Shelf was an innovative, systematic, and comprehensive project that produced a suite of sediment distribution maps and associated reports. These scientific outputs continue to be used by the fishing community and by seabed engineers for hydrocarbon development, cables and pipelines, and have formed the basis for the development of the new era of ecosystem management of the offshore. The project represented the world's first systematic seafloor geology mapping of a continental shelf.

Bay of Fundy Ecosystem Study

This multidisciplinary and multi-institutional project investigated the structure and dynamics of pelagic, subtidal and intertidal ecosystems in the macrotidal part of the Bay of Fundy. The research included studies of ice dynamics, salt marsh production and export, and a resident and migratory fish census. As a result of this project, the structure and dynamics of the unique ecosystems of the Bay of Fundy became much better understood.

Geology and Geophysics of the Scotian Margin and Grand Banks
This project produced the first published detailed study of the subsurface geology of the Scotian Basin. One of the major efforts of this ambitious mapping project involved interpretation of the regional geology of the Scotian Basin based on seismic data and well log analysis, and the correlation of these results with similar observations from the south and southeastern Newfoundland offshore.

1982-1992

Radionuclide Studies in the Arctic Ocean
This suite of projects was designed to identify contaminant pathways and estimate transit times and mixing rates associated with the circulation of Atlantic Water throughout the Arctic Ocean. This project started in the early 1980's and has been ongoing through 2012. Future efforts of this research are aimed at using radioactive tracers to characterize changes in circulation and particle/carbon transport in the Arctic Ocean that are associated with climate change and a reduced sea ice cover.

Ocean Drilling Program (ODP)
NRCan scientists sailed on or led 16 ODP cruises during the 1980's, when Canada was a full partner in the Ocean Drilling Program. Our scientists authored or co-authored 100's of papers on their results during this remarkable period of exploration and scientific discovery. Their efforts contributed to the success of what many consider to be the most successful international research program in the history of science. BIO scientist participation in the ODP contributed to the development of new knowledge about the geologic history of the world's ocean basins and the composition of their oceanic crustal rocks.

Optical Plankton Counter/Laser Optical Plankton Counter
This project involved the development of instruments to measure the size and concentration of zooplankton in the water column. The optical and the laser plankton counter are two instruments designed and built at BIO for counting plankton populations living at various depths in open marine water. The technology has been adopted by several west coast U.S. research institutions. It has also been offered for sale worldwide by a private Canadian company.

Canadian Ice Island
This project involved the occupation of a large ice island by BIO scientists for the first-ever study of the submarine Canadian Polar Margin seafloor lying beyond Axel Heiberg Island. The 5-year Canadian Ice Island project resulted in the first successful attempt to build and occupy a tabular iceberg in the Arctic Ocean that was required to carry out the pioneering scientific studies of the Canadian Polar margin. Results of the project revealed the existence of unknown Arctic biota and marine food chains. The project was also critical for planning the recent United

Nations Law of the Sea Program in the Arctic, for validation of Canadian Sovereignty on the Canadian Polar Margin, and for understanding the impact of climate warming on Arctic Ocean biota.

Geology of the Continental Margin of Eastern Canada
This project comprised a series of coordinated investigations that defined the nature and marine geological surficial and subsurface features of Canadian east coast continental shelf, slope and rise environments. Although the information in the resulting book was compiled in the 1980's most of the key points and maps are as relevant now as when they were written. The book remains essential reading for any researcher investigating the geology of offshore Eastern Canada, an area that stretches almost half the distance from the North Pole to the Equator.

1992-2002

Physical, Chemical and Biological Oceanographic Variability in the Labrador Sea
This ocean climate and ecosystem observation program was conducted in one of the most important areas of the global ocean. It is highly regarded internationally and an excellent example of the type of world-class multidisciplinary science that BIO has been able to foster and support.

Ecological Impacts of Mobile Fishing Gear on the Seabed
This interdepartmental and multidisciplinary study documented the environmental impacts of otter trawls, scallop rakes and clam dredges on seabed habitats and communities off Atlantic Canada and described the extent of their post-impact recovery. The results of this research had a major impact on the debate about the impacts of mobile fishing gear on benthic habitats.

Fate and Effects of Particulate Wastes from Offshore Hydrocarbon Drilling
This multidisciplinary study of the fate and biological effects of particulate drilling wastes was designed to help regulators manage the use and disposal of drilling wastes off Canada's east coast.

Geological Survey of Canada – Atlantic - Marine Geoscience Digital Initiative
This project transformed the GSC-Atlantic's analog seismic data collection to a digital format and replaced manual data processing methodologies with emerging digital systems-based technologies for collecting, processing and presenting marine geology data.

Moving Vessel Profiler (MVP)
This BIO-designed instrument has been used to collect fluorescence, sound velocity and zooplankton abundance information in the upper part of the water column. MVP's are now an integral part of oceanographic, seismic and hydrographic surveys around the world. The MVP is an example of the ability of the engineering group at BIO to envision, design and work with industry to develop a world-class research tool.

BIO's Response to the Swissair 111 Tragedy
The September 1998 crash of Swissair Flight 111 produced a multi-agency, rapid response effort that, among other things, mapped the seafloor of the crash site and provided advice on its

geology and seabed environments to agencies involved in the investigation of the incident. It is a classic example of rapid mobilization capabilities of the diverse types of marine expertise, located primarily at BIO, in response to a national emergency.

2002-2012

Spatial Utilization of Seabed Habitat by Demersal Fish
This interdepartmental and multidisciplinary study defined the preferred seabed habitat for juvenile haddock and its distribution on the Scotian Shelf. Other results of the research showed that the prime habitat for demersal fish varies considerably depending on the physical and biological properties of the habitat. This knowledge has, and will continue to assist fisheries management in improving the long-term sustainability of haddock and other demersal fisheries.

Development and Application of Oil Spill Countermeasures
Scientists in this multiagency-supported project improved existing and developed new oil spill countermeasures technologies for the protection of the aquatic environment and its living resources. Focusing on the application of "green technologies" that are based on the acceleration of remedial processes that naturally occur within the environment, the results from this research expanded the operational tools available to the global oil spill response community. This project established DFO Science as a global leader in the development of oil spill countermeasures aimed at protecting the ocean and its living resources.

Discovery Science in Support of the Gully Marine Protected Area (MPA)
This comprehensive and multi-departmental investigation of the Gully submarine canyon extended from the seafloor to the ocean's surface and from microbes to whales. The Gully MPA serves as a new millennium exemplar of how BIO's longstanding strengths in multidisciplinary science are consistently and innovatively applied to timely and pressing matters of marine environmental policy. This project was supported by BIO's legendary technological expertise that allowed the Gully MPA initiative to become a globally respected conservation accomplishment.

Ocean Profilers (SeaHorse, IceCycler, SeaCycler)
This engineering initiative resulted in the development of three systems that addressed the need for repetitive data collection over prolonged periods in ice-covered waters while conserving energy through the capture of wave power and buoyancy forces. SeaHorse and SeaCycler also have incorporated new technologies for sensor interfaces and data transmission via satellite. This technology was developed at BIO and is sold all over the world.

Variability in the Structure and Functioning of the Scotian Shelf Ecosystem
Using a wide range of empirical and modeling approaches, BIO scientists were able to interpret the causes of observed decadal changes in the structure and function of the Scotian Shelf. Interpretations included trophic cascades induced by overfishing of groundfish, biogeographical shifts in distribution due to climate variability, and seal-cod predator/prey interactions environment. The diverse interpretations have contributed to increased understanding of trophic interactions within the marine environment.

Bedford Basin Monitoring Program
The Bedford Basin Monitoring Program was initiated to document long-term ecological change in a part of the ocean that is of significant scientific, socioeconomic, cultural and historical importance to Canadians. As a result of this program, insights have been made into the biological organization of ecological systems and a new perspective was provided on how science conducted at the planktonic scale can inform decision-making at the human scale.

The Northern Labrador Charting Project
The completion of this project by the Canadian Hydrographic Service in 2007 signalled the end of a 75-year charting effort started by the British Admiralty in 1932. The eleven new charts produced by project participants help to ensure the safety of mariners when transiting the treacherous coastline of the Labrador Coast.

Multidecadal

BIO Mooring Technology
This project transcends all decades and is an enduring effort that is a good example of teamwork that produced new and more reliable mooring designs, innovations in mooring recovery techniques, and modifications to ocean current meters. Collectively, these developments resulted in a significant improvement in data quality. This program has supported BIO research initiatives for five decades.

TECHNOLOGY

The adverse conditions associated with working in the marine environment have always posed major technical challenges to seagoing scientists. The standard oceanographic sampling equipment available when BIO opened in 1962 had been in use for many years (i.e. bottles, grabs and nets). From the very beginning of BIO, high priority was given to building engineering capacity, both mechanical and electronic, that could develop new tools for improving the collection and processing of oceanographic data. In the early days, the availability of off-the-shelf instrumentation was limited and new tools had to be developed in-house to meet specific needs. This concerted engineering effort, conducted in close collaboration with scientific staff, was greatly assisted by the global digital revolution.

This section documents some of the many oceanographic instruments that were developed by BIO engineers in response to scientific needs. It also lists some of the new analytical methods, data logging systems and data base management tools that were also developed. Many of these products were successfully transferred to the private sector for commercialization.

1962

When BIO opened, the hydrographic vessels were equipped with conventional Decca for navigation, and Decca Lambda and Hi-Fix electronic positioning systems were coming into use for site-specific surveys. Offshore navigation was based primarily on celestial techniques that were very dependent on the weather. Work commenced immediately to improve both the range and accuracy of offshore positioning.

A start was made on developing a three-component thrust anemometer for measuring vertical transport in the atmosphere for air-sea interaction studies.

1963

A new model of the three-component thrust anemometer was developed that incorporated heat and humidity sensors. A wind tunnel was constructed to test and calibrate this new instrument.

A long-term program was begun to develop ocean moorings that could successfully carry internally recording instruments such as current meters. The initial moorings were restricted to shallow depths on the continental shelf and a good recovery rate was achieved.

Wave-rider buoys were developed that measured the vertical acceleration of the sea surface and radioed the data to a nearby shore station. These were initially tested in the Great Lakes.

1964

An analog to digital data converter was developed to produce digital data from magnetic tapes.

A stable platform buoy was developed to carry the thrust anemometer and other related sensors. It was first deployed from the CSS *Baffin* in an experiment off Aruba in the Caribbean.

The first deployments of deep-water current meter moorings were made between the shelf break and the edge of the Gulf Stream.

1965

Work continued on the development of the thrust anemometer and moored stable platform for the measurement of turbulent transport in the atmosphere over the sea surface and the equipment was tested off the coast of Prince Edward Island.

GEODAL, a semi-automated geophysical data logging system, was developed for use on BIO ships.

Work began on developing a hydrostatic rock core drill. It was designed to work at depths greater than 800 m on the Mid-Atlantic Ridge to collect bedrock samples to confirm and quantify the new theory of plate tectonics.

A method was devised for accurately determining the relative position of the CSS *Hudson* over the Mid-Atlantic Ridge using radar transponder buoys.

1966

Work began on the development of a radio-controlled sounding launch that would permit hydrographic survey work to be carried out in rough seas when manned launches could not be safely deployed from the mother ship.

The BIODAL data logging system was developed. It was similar to GEODAL but improved and more versatile. It was designed to be a standard data recording facility for all BIO ships. Data recorded included day number, time, ship's heading and ship's log. Once operational, systems were installed on CSS *Hudson* and CSS *Baffin*.

A sediment heat probe was developed for measuring the temperature of sea floor sediment. Temperature was measured at three points along the barrel of a conventional sediment corer and determination of the thermal conductivity of the sediment recovered enabled calculation of the heat flow through the sea floor.

In response to the growing need for more efficient tools for estimating fish stock abundance, work began on using acoustic signals produced by echo sounders to count fish.
Work began on the development of Batfish, a towed vehicle carrying multiple sensors capable of moving vertically through the water column in a porpoise-like, undulating fashion.

1967

A variable depth echo sounder transducer was designed and tested on CSS *Hudson*.

The instrumented stable platform buoy for air-sea interaction studies was moored in the approaches to Halifax Harbour. It was fitted with an upgraded suite of sensors and operated for 20 months until it failed in a severe winter storm.

After several years of development, a prototype hydrostatic rock core drill was built and successfully tested. It was powered by hydrostatic pressure and included a unique load-sensing automatic download mechanism.

1968

Work continued on the development of the radio-controlled survey launch.

The Hydrographic Automated Acquisition and Processing System, a hard-wired data-logging unit that recorded survey data on punched paper tape, was designed and built. This development set the scene for a long line of advances in data logging systems used aboard hydrographic ships and launches.

The mooring program continued to improve components and techniques so that instrumented moorings could be deployed in deeper water, stay out longer and be successfully recovered. Components investigated included subsurface floats, backup buoyancy, anchors and parachutes, acoustic releases and recording meters.

After further improvements, the hydrostatic rock core drill was fully operational and used to collect cores on the Mid-Atlantic Ridge and the Rehoboth Seamount. The drill was widely used up to the mid-1980s to obtain valuable bedrock samples that would not have been possible without using a much more expensive specialized drill ship.

Building upon the success of the hydrostatic rock core drill for deep-water applications, a start was made on developing a rock core drill for use in shallow depths on the continental shelf. Since a shallow water drill could not rely on hydrostatic pressure for power, and more power was needed due to the greater sediment overburden and harder bedrock expected, the new drill was powered by electricity from the ship.

An integrating radiometer was built to measure submarine light energy as part of phytoplankton primary productivity studies.

Work continued on the development of an acoustic echo-counting system for obtaining information on the abundance and distribution of fish stocks that could be used to complement data collected by trawl surveys.

1969

The first electric powered rock core drill was successfully tested by drilling into Precambrian rock on the Flemish Cap. Having an uninterrupted electrical power supply meant that the drill's operation could be observed and controlled from the surface.

An automated system was developed to continuously measure chlorophyll concentration throughout the water column. A submersible pump fed a continuous flow of water into a fluorometer and synoptic surveys of phytoplankton distribution could be conducted for the first time over large areas.

1970

The BIO navigation group was created to carry out mission-oriented research and development in all aspects of navigation.

After several years of development, the undulating towed underwater vehicle named Batfish was operational. It could be operated between the surface and depths up 180 m while being towed at speeds up to 10 knots. A Guildline CTD was installed.

Hermes Electronics Ltd was granted licences to manufacture and market Batfish and the hydrostatic rock core drill.

Deep-water current meter moorings were deployed successfully in the Drake Passage during the Hudson 70 Expedition and later under the Gulf Stream.

As a result of a Scientific Committee on Ocean Research intercomparison project, Aanderaa current meters were selected as the standard for BIO programs and used for many years and deployments.

An instrument named Digibridge was developed to measure temperature with a high degree of accuracy and precision. It was deployed on a mooring, activated by an acoustical command and provided time series of temperature for up to twenty days.

The first rosette sampler was built. Ten PVC sampling bottles of 1.3 L capacity were mounted on a ring around a STD. The bottles were closed sequentially by means of a shipboard command signal. It could operate down to 2500 m.

1971

Techniques were developed for setting current meter moorings up to 2000 m deep in the strong currents of the Gulf Stream.

The radio-controlled survey launch was successfully tested in Antigua and during a cruise to the Mid-Atlantic Ridge.

Two prototype *in situ* optical attenuence meters (nephelometers) were built and successfully evaluated in the field as a more rapid method for measuring particle concentrations in seawater.

A project was initiated to develop acoustic methods for locating and mapping the distribution of zooplankton and euphausiids in shelf and slope waters using towed dual frequency acoustic sounders.

1972

Development of the electric rock core drill continued. With time, the drill could be operated in deeper water and improvements were made in the design of the drill frame to improve stability and handling the umbilical cable. This drill was used successfully in many programs during the 1970s and 1980s.

Under the newly announced federal Make-or-Buy program, a start was made on the development of a towed seismic system in collaboration with Huntec '70 Ltd. The goal was to develop a system operable in open ocean conditions and capable of achieving 0.2 m layer resolution and penetration of 200 to 300 m in clay sediments when towed at speeds up to 10 knots. This system became known as the Huntec Deep Tow Seismic (DTS) system.

1973

A short-baseline acoustic positioning system was developed to help hold the CSS *Hudson* on station while coring seafloor sediments. A portable version of the system was also developed and used to position a manned submersible during the recovery of a sunken helicopter off Halifax Harbour. A long-baseline acoustic positioning system, a bottom referencing system, was developed a few years later and used successfully in several programs.

1974

An in-depth Make-or-Buy analysis was carried out for the entire Institute and a number of technology projects with a potential for contracting out were identified. It was anticipated that a substantial portion of the BIO technology program could be achieved in partnership with Canadian industry. While the design and development of new oceanographic sampling tools was carried out by BIO engineers in conjunction with scientific users, it was envisioned that some technology, once proven, could be passed on to commercial interests for production and sales.

A wave follower instrument was developed and deployed. This bottom-mounted tower contained a hydraulic ram that moved up and down with the sea surface and was fitted with wind and pressure sensors a few centimeters above the sea surface. The resulting data were used to measure the momentum and energy transfer between the atmosphere and waves.

A sidescan sonar system was developed that was capable of mapping the seabed at ranges over 1 km at relatively high survey speeds.

OCTUPROBE (OCeanic TUrbulence PROBE), a vertically profiling free-fall vehicle equipped with temperature, conductivity and turbulence sensors, was developed to measure ocean turbulence and microstructure.

Development of the Huntec Deep Tow Seismic system continued. Field trials were conducted and the quality of seismic records was outstanding. It was recommended that the system be incorporated immediately into BIO's geophysical survey suite of equipment and that a multi-year R&D program should be undertaken to further develop the system.

Work continued on the development of a computerized acoustic fish counting system that combined automatic processing of echo returns with data analysis to provide estimates of the numbers and sizes of different fish.

1975

The BIONAV (BIO Integrated Navigation System) program was initiated to integrate the outputs from the numerous navigation devices used on BIO ships and provide more accurate navigation data. These devices included the Transit Satellite System, rho-rho Loran-C, Decca and the ship's log and gyro.

The five-year Seabed I Project was begun to further develop the Huntec Deep Tow Seismic system. This technological development project improved the application of this tool to geological mapping of the seabed. The upgraded system was successfully tested on a CSS *Hudson* cruise to the Grand Banks.

Work began on the design of an ocean bottom seismometer that would operate in the quiet seabed environment and enhance the ability to investigate the deep crustal structure of the oceans.

Wind stress measurements were made using the thrust anemometer mounted on the stable tower moored at the entrance to Halifax Harbour. The equipment was controlled by radio from BIO and data telemetered ashore.

Moored sediment traps for ecological studies were designed and constructed. They were used subsequently to determine the settling rate of suspended particulate matter in various coastal bays including Bedford Basin and St. George's Bay.

A bottom-crawling remotely controlled vehicle called Sea Rover was constructed and used to estimate the amount of fuel oil remaining on board the sunken barge *Irving Whale* in the Gulf of St. Lawrence north of Prince Edward Island. The powered vehicle was controlled from the surface via an umbilical cable and fitted with an acoustic transponder, a television camera and navigation equipment.

Batfish evolved into a vehicle with a bottom avoidance system able to collect temperature and salinity data in the top 400 m on a continuous basis as it moved horizontally and vertically through the water. In addition, it was fitted with a fluorometer to get a two-dimensional picture of chlorophyll concentrations.

1976

The Canadian Ocean Data System (CODS) project was initiated in collaboration with Hermes Electronics Ltd. The project was based on the concept of acquiring meteorological and oceanographic data from a number of moored surface buoys and transmitting this information to shore stations by a radio link. The preliminary investigation included the design of the buoys and associated sensors (including temperature and atmospheric pressure), telemetry, data processing systems, the testing of prototype buoys and establishment of user needs. A number of prototype buoys were developed and tested near the stable platform buoy at the mouth of Halifax Harbour. As part of the CODS program, a study was begun to determine if a standard production line yacht hull could serve as a suitable oceanographic buoy. A hull was purchased, equipped with meteorological and motion sensors and tested with other CODS buoys at the mouth of Halifax Harbour.

The new high-resolution Huntec seismic profiling system was used effectively to locate near-surface bedrock within range of the 6 m rock core drill. Shallow cores of Late Ordovician and Silurian sedimentary bedrock were recovered on the shelf east of southern Newfoundland.

Ocean bottom seismometers, using designs from the Hawaiian Institute of Geophysics, were constructed and successfully tested on the west coast.

1977

OCTUPROBE II was developed to improve the measurement of ocean turbulence and microstructure.

The BIONESS (BIO Net and Environmental Sensing System) was developed and used extensively for studying the spatial distribution of zooplankton and related oceanographic variables. A system of ten opening and closing nets controlled from the surface, each with an opening of 1 m^2, allowed multiple samples to be collected from ten depths while underway. It also carried sensors to measure temperature, salinity, depth, speed, water volume, chlorophyll and light.

The electronic (optical) plankton counter was developed. A light beam was used to determine the size of animals that broke the beam and the light attenuance of the water provided a measurement of plankton biomass. This plankton counter was subsequently mounted on a Batfish fitted with a CTD and fluorometer for measuring chlorophyll. This ‘biological’ Batfish was used for many years to collect detailed information on the spatial resolution of plankton in surface water.

A benthic sampling chamber was designed and constructed to collect serial samples of water and particulate material over undisturbed sediments while sitting on the seafloor. It was successfully deployed in St. George's Bay and on the Scotian Shelf to determine chemical fluxes between sediments and the overlying water column.

1978

BIONAV was fully developed and successfully used for the first time on a calibration cruise. Soon after, the software program was installed on all BIO vessels and freely distributed to other institutions and private companies across the country for their use. It became the standard BIO navigation system until replaced by the Global Positioning System (GPS) in the late 1990s.

As part of the Canadian Ocean Data System (CODS) program, a large fibreglass discus meteorological buoy was developed and tested on the Scotian Shelf south of Halifax with sensors for wind speed and direction, air pressure and temperature. The buoy remained on station for a year and half and produced data of excellent quality. The experimental yacht hull buoy was modified to include a new mast, a new radar reflector, a new mooring and the addition of ballast and was tested again at the mouth of Halifax Harbour.

In support of studies in the Bay of Fundy, geologists developed methods to estimate suspended sediment concentrations from Landstat satellite multispectral imagery, to map intertidal bedforms using cameras in tethered blimps and to measure intertidal sediment transport using radioactive glass beads.

1979

Graphical Online Manipulation and Display System (GOMADS), an interactive cartographic system that allowed cartographers to digitize and edit data during chart production, was developed. GOMADS was later transferred to industry and evolved into Computer Assisted Resource Information System (CARIS) that became widely used by many agencies in Canada and around the world.

A surface drifter was developed that was able to measure atmospheric pressure and sea surface temperature over periods of a few years. The instrument was subsequently deployed in large numbers for many years to study ocean surface currents.

The improved Huntec Deep Tow Seismic system was successfully tested on the Scotian Shelf.

Work began on the development of Ralph, a freestanding instrumented tripod deployed on the seabed to monitor the processes controlling sediment transport. Sensors included a pressure transducer to measure waves, current meters to measure current speed and direction, sonar to measure bedform changes, an optical attenuence meter to measure suspended sediment and a time-lapse camera. Ralph was subsequently deployed for periods up to two months in a wide variety of environments including the Arctic, Hibernia on the Grand Banks, Sable Island Bank, the Saguenay Fiord and Lake Winnipeg.

1980

In collaboration with ISE Ltd, the Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation (DOLPHIN) program was initiated with the goal to develop a submerged remote-controlled vessel for hydrographic surveys.

Also in collaboration with ISE Ltd, hydrographers began the Autonomous Remote Controlled Submersible program utilizing a torpedo-like vehicle that contained an acoustic positioning system, echo sounder, data logging system and acoustic telemetric control link for under-ice hydrographic surveys in the Arctic.

Further testing of the improved Huntec Deep Tow Seismic system was conducted on the Scotian Shelf. By this time, the system had been successfully used on government offshore survey programs carried out in Bay of Fundy, Georges Bank, Sable Island Bank, Grand Banks, Labrador Shelf and Baffin Bay. Huntec '70 Ltd. successfully brought a commercial version of the Deep Tow Seismic system to market with fully operational units being deployed in Canadian waters, the North Sea, and offshore Norway, Gulf of Mexico, Arctic and Antarctic oceans.

The first ocean bottom seismometer became operational. The lower noise and better signal processing allowed government and university geologists to probe the deep crust using airguns instead of dangerous explosives.

A continuous pump sampler was developed for profiling the vertical distributions of phytoplankton and zooplankton in the upper 100 m of the water column while the ship was on station.

1981

Techniques were developed for conducting hydrographic surveys in near shore areas using stereo cameras mounted on a helicopter and successfully tested at Sable Island. Further work in collaboration with the Canada Centre for Remote Sensing led to the development of a scanning Light Detecting and Ranging (LiDAR) system that was later transferred to industry for commercialization.

Procedures for deploying moorings continued to improve. Since 1970, the number of current meter moorings laid per year doubled and the operational period increased by a factor of six.

Following the success of Project Seabed, a larger Project Seabed II was initiated, again in cooperation with Huntec '70 Ltd., with the goal of making further improvements to the Huntec Deep Tow Seismic system including increasing the depth capability to 2000 m, adding sidescan sonar and incorporating a system to present spatially corrected data in real time.

The Optical Plankton Counter was developed to replace the electronic plankton counter. It was mounted on Batfish with other sensors and could be towed at speeds up to 10 knots. Plankton tows were no longer limited by space or time.

Baited traps equipped with time-lapse cameras were developed to study scavenging animals in the deep sea and successfully deployed at 5,820 m on the Nares Abyssal Plain. These provided the first estimates of feeding rates of deep-sea animals.

1982

The prototype LiDAR system was further developed and tested in-house and later transferred to OPTECH Ltd. for commercialization.

An instrument named EPSONDE was developed. It had the same sensors as OCTUPROBE but the tether was a four-conductor Kevlar cable that sent data to an onboard computer allowing longer and deeper deployments to measure the microstructure of ocean turbulence. It could measure temperature differences of 0.05 C and minor fluctuations in turbulent velocity. It could also be deployed in a tethered-free-fall mode.

A modified version of the Optical Plankton Counter was developed for operation on deck or in the laboratory.

A temperature-controlled incubator, termed the photosynthetron, was developed and used to measure the short time-scale response of phytoplankton photosynthesis to changes in available light. This innovation led to the rapid accumulation of data on the light-dependent parameters of photosynthesis that became the building block of a great deal of later work.

The BIONESS electronic controlled multiple net system technology was transferred to Eastern Marine Services for commercialization.

1983

The Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation (DOLPHIN) acceptance trials were successfully held. Powered by a diesel engine, DOLPHIN could run 4 m below surface with only an air intake and antenna for the remote control above the surface. Clean data sets were produced because the echo sounder transducer was positioned below surface aeration caused by wave action. However, there were problems launching and retrieving DOLPHIN from the CCS *Baffin* in rough seas. Three prototypes were subsequently built in British Columbia.

Trials of the improved Huntec Seabed II seismic system for seabed mapping were successfully conducted on CSS *Hudson*.

A floc camera was developed that could record the undisturbed suspended sediment structure in the water column for later analysis.

The Batfish technology was transferred to Guildline Instruments Ltd. for manufacturing and marketing.

The Canadian Marconi Company was licenced to manufacture and market the BIO ocean bottom seismometer.

Work continued on the development of an acoustic fish counting system for research and fish inventory. A dual-beam system, now called ECOLOG, was built and tested to provide better estimates of fish size and stock abundance.

1984

Further improvements were made to Batfish so it could be towed at 8 knots down to depths of 200-450 m.

A Canadian east coast Loran-C chain became operational which markedly improved electronic navigation. This system remained in operation until early 2010 by which time ground station radio-wave navigation systems were superseded by the satellite-based Global Positioning System (GPS).

Electronic chart test-bed trials were successfully held in Bedford Basin.

A prototype of the Autonomous Remotely Controlled Submersible, which was designed to conduct hydrographic surveys under permanent ice cover, was successfully tested and exhibited at the Canadian Offshore Resources Exposition in Halifax. However, funding cuts and changing priorities terminated the project.

Further trials with the improved Huntec Seabed II seismic system were conducted by the CSS *Hudson* in Verrill Canyon. Towed at depths down to 2000 m, the system performed flawlessly and produced the first high-resolution seismic profiles with over 200 m sub-bottom penetration. Its sidescan sonar covered 2.5 km on either side of the towfish.

An in-house image analysis system for remote sensing and other applications was installed.

1985

Ice beacons were designed and built in collaboration with Hermes Electronics Ltd. They measured ice and water temperature profiles, ice pressures and position and were deployed from helicopters to study the properties and movement of pack ice off Labrador. All data were transmitted in real time back to BIO via satellite transmission systems. Forty-two ice beacons were deployed between 1985 and 1989.

The Rosette/CTD system was further developed and integrated the CTD electronic probes with 24 large volume water sampling Niskin bottles which could be closed on command from the surface. This new system greatly simplified sampling the water column for determining numerous physical, chemical and biological variables.

A program of instrument development and sampling of under-ice algae and zooplankton began. This new equipment was deployed remotely through ice holes in Lancaster Sound, NWT. It was able to measure currents, the distribution of under-ice algae, determine their growth rates and collect amphipods.

1986

The first 25 years of BIO were marked by a period of rapid technical development, both worldwide and in-house, driven by the revolution in microelectronics and the advent of the digital age. By now, many measurements were made *in situ* using new sensors, remote sensing and satellite usage were expanding, costs for computing were dropping while memory was increasing, and data transmission through satellites and computer networks was becoming standard practice.

The efficiency and feasibility of transmitting and receiving mapping information via the ANIK-D Satellite Network was tested.

The long-term investment of resources in improving the design and operation of mooring equipment since BIO was established continued to pay dividends to many programs. The current meter mooring recovery rate was now greater than 95%.

An ice-monitoring platform was developed in collaboration with Metocean Data Systems. Deployed by helicopters, these platforms collected temperature profiles of surface water, ice and atmosphere used to study the life cycle of sea ice.

1987

AIMS-1, the first Arctic Ice Monitoring System, developed by BIO engineers and Seimac Ltd., successfully completed tests in Halifax Harbour and was deployed in the Northwest Passage.

Hydrographers assisted the International Hydrographic Office in developing draft specifications for electronic charts.

The Benthic Organic Seston Sampler (BOSS) was designed and constructed. This mechanically operated, ship-deployed tripod was designed to sample water and suspended particulate matter in the benthic boundary layer (within 0.5 m of the seafloor). It was used subsequently in various programs including studying the release of drilling wastes from offshore oil and gas platforms.

1988

The test bed electronic chart system, interfaced to radar, was tested against other prototype electronic chart systems in the Baltic and North Seas.

1989

Working in collaboration with the International Hydrographic Office, BIO hydrographers designed the screen display of the official electronic chart.

The Moving Vessel Profiler (MVP) system was developed in partnership with Brooke Ocean Technology. It was used to deploy a variety of oceanographic sensors while the ship was underway. This improved system was much simpler to operate, had a greater depth range and could be deployed from research vessels, merchant vessels and ferries.

1990

The Optical Plankton Counter technology was transferred to Focal Technologies Ltd. for production and marketing.

1991

A benthic annular flume named Sea Carousel was developed and successfully deployed to study sediment transport processes in intertidal and subtidal environments.

The Bottom Referencing Underwater Towed Instrumented Vehicle (BRUTIV), initially developed at the St. Andrews Biological Station in the 1970s, was significantly modified and upgraded. BRUTIV was a towed underwater vehicle controlled from a mother ship that could fly at a set depth or constant altitude above the seabed. It was used to collect video and still imagery along transects at numerous locations on the continental shelf.

A large laboratory flume tank was designed and constructed to study the effects of hydrocarbon drilling wastes on sea scallops under realistic exposure conditions.

1992

The Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation (DOLPHIN) vessels were outfitted with EM100 multibeam echo sounder systems and transferred to industry.

Ice Probe was developed. This helicopter-towed instrument was designed to monitor pack ice properties as a complement to on-ice sampling and deployment of ice beacons. The three main components were an electro-magnetic sensor, a ground-penetrating radar sensor and a video camera system with a laser altimeter.

A moored instrument, based on the BIO Optical Plankton Counter, was developed to continuously monitor zooplankton population changes. The instrument was deployed successfully for several extended periods to monitor zooplankton populations in Emerald Basin.

The AGC navigation display and logging system (AGCNAV) was developed. This PC compatible system was designed specifically for marine scientific surveying and sampling. It produced a versatile graphic display of the positions of the ship and up to six different acoustic targets along with important data such a Julian day, time, ship position, heading and speed. It was widely used in numerous BIO field programs for many years.

Based on an earlier design, a quantitative epibenthic sled was constructed for collecting large benthic organisms on the continental shelf. Modifications included installing a remotely controlled opening and closing door mechanism, meter wheel and video camera to observe performance.

Videograb, a hydraulically-actuated bucket grab equipped with video cameras was designed and constructed along with a custom winch capable of holding 1000 m of conductor cable and a companion sheave block. Videograb was designed to minimize disturbance to the sampling area and provided the operator with the ability to visually select the precise sampling area on the seabed, close and open the bucket remotely and verify that the bucket closed properly prior to recovery. It subsequently became a workhorse used to quantitatively sample benthic organisms in a wide variety of seabed habitats.

1993

In collaboration with the University of New Brunswick, a high precision ship motion sensor system was developed to measure yaw, pitch and roll to improve the quality of multibeam electronic sounder data.

In collaboration with the ORACLE Corporation, the hydrographic hyperspatial code was developed and used to construct the data bases needed to store the millions of soundings collected by the new multibeam electronic sounding systems on BIO ships. The commercial result of this venture was the ORACLE Geospatial data base management system.

The Submersible Observation of Benthic Stability benthic tripod was developed. Similar to Ralph, it was equipped with optical backscatter sensors, a pressure transducer and a video camera to study sediment transport processes. It was successfully deployed in Miramichi Bay.

Lancelot, a remotely deployed autonomously operated seabed instrument, was developed for measuring pore water pressure in soft sediments. Soon after, this was followed by the development of Excalibur which was similar to Lancelot but was also able to collect samples of pore water.

Through an agreement with Focal Technologies Ltd. and Guildline Instruments Ltd., further improvements were made to Batfish.

1994

Further progress was made in the development of the moving vessel profiler in collaboration with Brooke Ocean Technology Ltd. The stability of the conductivity/temperature/depth probe was successfully tested on the CCGS *Frederick G. Creed* at the high towing speeds (up to 22 knots) expected on container ships.

Campod, a lightweight instrumented tripod equipped with high-resolution video and still cameras, was developed. It was designed with an open profile and wide stance to minimize disturbance to the seabed. It used the same laboratory controls, slip rings, winch, cable and sheave block as Videograb and could be used on any kind of bottom. It could be fitted with other sensors, including a suction device for sampling the floc layer on the seabed. Like

Videograb, Campod became a workhorse and was widely used for many applications. This instrument was copied by other laboratories.
Engineers developed a moored instrumented monitoring system (MIMS) for measuring the properties of particulate material close to the sea floor. It included sensors to determine the concentration of suspended particles, photograph flocculated material and measure turbulence. A telemetry system transmitted data by way of a satellite transmitter to either a nearby drilling rig or ashore. This system was successfully tested at Hibernia.

1995

A sound velocity profiler was developed that could be used underway from ships and launches to improve the efficiency and accuracy of data from multibeam electronic sounding surveys.

Seahorse, a slightly buoyant platform using the mooring motion caused by waves to move itself to the bottom of its vertical cable, was developed. It carried CTDs, fluorometers, turbulence probes and current meters and was able to profile the water column. Cell phone technology was used to send the data to shore in near real-time. Seahorse was subsequently licensed to Brooke Ocean Technology for production and sales.

EPSONDE was incorporated into a tethered free-fall glider configuration to measure the vertical profile of turbulence and its microstructure.

1996

Ralph was used to collect several long-term data sets of boundary layer dynamics and bedform movement under storm conditions on Sable Island Bank. These data were used to construct numerical models such as SEDTRANS to estimate sediment transport on the Scotian Shelf.

1997

Development began of the Laser-Optical Plankton Counter. It was designed to solve the deficiencies of the first generation of optical plankton counters.

A biological monitoring system named Habitrap was developed to observe the sublethal effects of drilling wastes on suspension feeding organisms such as mussels and scallops. A sediment trap collected feces and these samples allowed the calculation of bivalve growth rate, reproductive potential, and survival. Habitrap was successfully tested at the Hibernia oil production platform.

1998

Towcam was developed as a more dependable replacement for BRUTIV. This towed vehicle collected video and still imagery of seabed habitat and large surface dwelling organisms over transects many kilometers in length. It was flown at an altitude about 2 m off the seabed which gave a field of view about 1 m wide. It was subsequently used in numerous seabed habitat studies on the continental shelf.

1999

Work began on the development of the Virtual Data Centre. This web-based common computer working environment became the central depository for a variety of fisheries survey data sets, each with a well-documented set of metadata allowing scientists to conveniently access the data needed for ecological analyses.

2000

A Coastal Information System was developed which evolved into a sophisticated Arc-Oracle geospatial database system incorporating dynamic segmentation with the capability for documenting alongshore and cross-shore variability in coastal geomorphology and sediments at high resolution.

BIO assumed responsibility for maintaining a fleet of profiling drifting floats over the entire western Atlantic Ocean as part of Canada's contribution to the global fleet of drifters as part of the international ARGO program. These ALACE drifters are able to obtain up to 150 temperature and salinity profiles from the surface to 2,000 m over a period of 4-5 years and transmit the data ashore via satellite.

2001

Ice Probe evolved into a new instrument named Ice Pic that was mounted as a tubular projection on the front of a helicopter. It was equipped with the same sensors as Ice Probe and used in further studies of pack ice.

INSSECT (IN situ Size and SEttling Column Tripod) was developed for sediment transport studies. It included a digital silhouette camera to monitor suspended particle size, a video system to measure particle settling rates, a modified sediment trap to capture flocs in gels for post-recovery measurements and a current meter. The ability to measure the particle size and settling velocity, as well as the water velocity, provided data to predict the dispersion of materials from natural phenomena or anthropogenic activities.

2002

Plans were initiated to develop a new instrument called Icycler which could collect repetitive vertical profiles of oceanographic data while moored at a fixed location under ice. A patented energy conservation technique was developed to operate it. The instrument included a sensor float, a mechanism float and anchoring components.

2003

Icycler was successfully deployed under the ice at a depth of 200 m in Lancaster Sound and collected a full year's worth of valuable oceanographic data.

The Laser-Optical Plankton Counter was fully developed and tested. By designing a new optical path, the resulting instrument was much more compact. The technology for this new design was transferred to Brooke Ocean Technology for production and sales.

2004

An outdoor wave tank was constructed to study the effectiveness of oil spill dispersants under controlled conditions.

2005

An interim Atlantic Tsunami Warning System was developed that linked existing tide gauges to a server giving weather forecasters real-time access to high frequency water level observations.

2006

Icycler was successfully deployed for a second time under the ice in Lancaster Sound and collected another full year's worth of valuable oceanographic data.

The Remotely Operated Platform for Ocean Sciences (ROPOS), now operated by the Canadian Scientific Submersible Facility in British Columbia, was deployed for the first time from the CSS *Hudson* and successfully used for benthic studies in the Northeast Channel.

2010

Building on the success of Icycler, a consortium consisting of BIO, Scripps Institution of Oceanography (US), GEOMAR Helmholtz Centre for Ocean Research (Germany), Bremen University (Germany), the National Institute of Oceanography (UK) and Rolls Royce Canada Limited-Naval Marine was established to develop Seacycler. The same patented energy conservation technique developed for Icycler was employed. Specifications called for deployment in the open ocean at depths up to 5,000 m, the capability of profiling the top 150 m of the water column with a substantial sensor suite and the ability to transfer data ashore by means of satellite.

2011

Seacycler was successfully deployed and tested at a site on the edge of the continental shelf south of Halifax. Temperature, salinity and dissolved oxygen were measured on 644 profiles, 150 m deep, over a six-week period and data were recovered in real time.

A prototype ice/ocean observatory was developed and installed in the Barrow Strait, NWT. An acoustic telemetry link transmitted data collected by moored instruments to an underwater hub, a sub-sea cable carried the data to a shore station and a two-way satellite link transmitted the data to the distant scientist.

2012

Seacycler was successfully deployed for a second time over a seven-month period at a site in 2,500 m of water southeast of Cape Cod.

CONFERENCES AND WORKSHOPS

This section lists the major international, national and regional conferences and workshops that have been held at BIO. Also included are meetings organized by BIO staff but held off campus, usually in Halifax, and BIO Open Houses. Undoubtedly some events are missed because they were not recorded in the Annual and Biennial Reviews, especially in the early years.

1962

The first BIO Open House was held the day after BIO was officially opened.

The Canadian Committee on Oceanography met at BIO, its first meeting held outside of Ottawa.

1963

BIO hosted the 1963 Annual Meeting of the Scientific Committee on Oceanic Research (SCOR).

1974

BIO engineers played a major role in organizing Ocean '74, the fifth Institute of Electrical and Electronics Engineers International Conference on Engineering in the Ocean Environment, held in Halifax.

1975

BIO hosted a 3-day Open House attracting 15,000 people.
BIO scientists helped organize Benthonics '75, the first international symposium on benthic foraminifera of continental margins, held in Halifax.

1976

BIO scientists assisted in the organization of a joint meeting of the American Association of Stratigraphic Palynologists and the Commission Internationale de Micropaléontologie Paléozoique that was held in Halifax.

1977

A NATO Advanced Studies Institute on Spatial Patterns in Plankton Communities was organized.

BIO scientists organized and hosted the International Symposium on the Recovery Potential of Oiled Northern Environments that was held in Halifax.

A conference on the Pacific, Arctic, Atlantic and Great Lakes coastlines of Canada was organized by geologists and held in Halifax.

1978

A workshop was organized to examine the environmental impacts of the Canso Causeway constructed in 1954.

1980

Following the opening of the new buildings, BIO held a three-day Open House attended by 25,000 who viewed 56 exhibits and toured the facilities.

BIO hydrographers organized the 19th Annual Conference of the Canadian Hydrographer's Association held in Halifax.

BIO geologists played a major role in organizing the 1980 Joint Annual Meeting of the Geological Association of Canada and the Mineralogical Association of Canada.

BIO hosted the annual meetings of the Association of Earth Science Editors and the International Association of Marine Science Libraries and Information Centers.

1981

BIO scientists organized the international symposium entitled Dynamics of Turbid Coastal Environments to highlight recent research in the upper reaches in the Bay of Fundy and compare the results with other similar regions around the world. This was the first major symposium held in the new auditorium.

In collaboration with the Woods Hole Oceanographic Institution, BIO scientists organized the international Ocean Pollution 1981 Conference.

1982

BIO scientists played a leading role in the organization of the 5th Joint Oceanographic Assembly that was attended by hundreds of oceanographers from around the world and held at Dalhousie University. BIO scientists were high profile participants and BIO facilities were put on display.

BIO scientists organized a workshop, sponsored by the Atlantic Provinces Inter-University Committee on the Sciences and held at the University of Moncton in Moncton, NB, to review recent environmental research in the Bay of Fundy and reassess the possible impacts of tidal power development.

BIO scientists helped organize the Second Canadian Marine Geotechnical Conference.

1984

BIO hosted a five-day Open House that attracted over 30,000 visitors who viewed exhibits, toured research vessels and attended lectures of popular interest.

At the request of the Scientific Committee on Ocean Research (SCOR), BIO scientists organized an international meeting held in Laval, QC, to review the application of thermodynamics, information theory, flow analysis and statistical mechanics to biological oceanography.

BIO scientists contributed to the organization of the 2nd Joint Annual Congress of the Canadian Meteorological and Oceanographic Society and the Canadian Geophysical Union held at Dalhousie University.

BIO hosted a special meeting on the biology and ecology of squids in the northwest Atlantic organized by the North Atlantic Fisheries Organization (NAFO).

BIO hosted the annual meeting of the International Commission for the Conservation of Atlantic Tunas.

BIO staff contributed to the organization of the Fourth Canadian Offshore Resources Exposition held in Halifax.

1985

BIO hydrographers organized the Annual Conference of the Canadian Hydrographer's Association held in Halifax.

1986

An oil spill impact assessment workshop was held with participation from several government agencies, local environmental consulting firms and Dalhousie University to discuss the usefulness of the Grand Banks holistic ecosystem model developed at BIO for predicting potential impacts from oil spills.

1987

BIO held a Students Day.

BIO hosted the annual meeting of the Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO).

BIO scientists assisted in the organization of Oceans 87, the joint Marine Technology Society/Iinstitute of Electrical and Electronics Engineers annual conference and exposition held in Halifax addressing the theme, 'The Ocean: An International Workplace'.

BIO scientists organized an international Georges Bank Research Workshop bringing together government, university and industry scientists from both Canada and the US to discuss recent research and its application to potential impacts of proposed hydrocarbon drilling.

BIO hosted the 9th Annual Canada-United States Scientific Discussions Conference to discuss the biology and management of coastal marine fish populations.

1988

An exhibition of cooperative programs between the Department of Fisheries and Oceans and the Department of Energy, Mines, and Resources was held at BIO.

BIO hosted the first National Hydroacoustics Workshop which addressed the potential applications of acoustic technologies in fisheries research, biological and physical oceanography, hydrography, geosciences and marine mammal research.

BIO hosted the international Interdisciplinary Conference on Natural Resource Modelling and Analysis that attracted scientists from over a dozen countries.

BIO scientists organized the third annual national Long-Range Transport of Atmospheric Pollutants (LRTAP) Workshop. Topics discussed included the use of liming to reduce the adverse effects of acidification and the significance of airborne organic and metal pollutants. BIO scientists organized a second international Georges Bank Research Workshop bringing together government, university and industry scientists from both Canada and the US to discuss recent research and its application to potential impacts of proposed hydrocarbon drilling.

BIO staff were involved in the organization of Pacem in Maribus XVI, a conference and exhibition covering ocean technology development, training and transfer, sponsored by the International Ocean Institute of Malta.

BIO scientists led a national DFO workshop on recruitment to fish populations.

1989

BIO scientists organized the Canadian Continental Shelf Seabed Symposium to exchange knowledge, develop new research thrusts, and document current research on the nature and stability of the Canadian continental shelf seabed in terms of the physical and chemical environments and the associated biological communities.

BIO scientists organized a third international Georges Bank Research Workshop bringing together government, university and industry scientists from both Canada and the US to discuss recent research and its application to potential impacts of proposed hydrocarbon drilling.

BIO scientists organized the Halifax Inlet Research Workshop to provide an informal forum for the presentation and discussion of research results and plans pertaining to the proposed installation of a major sewage treatment facility in Halifax Inlet. Over one hundred persons from a variety of agencies and interest groups attended.

1990

BIO hosted a three-day Open House, preceded by a Client Day. Almost 30,000 attended.

BIO hosted the Global Ocean Ecosystems Dynamics workshop, sponsored by the U.S. Joint Oceanographic Institutions, to evaluate the likely consequences of changes in global climate and physics on the sustainability of animal production in the sea.

BIO scientists organized the 1990 Canadian Workshop on Harmful Marine Algae involving participants from government, academia, and industry that reviewed recent research in the ecology, toxicity, monitoring, and chemistry of toxin-producing algae.

BIO scientists assisted in the organization of the Joint Annual Meeting and Conference of the World Aquaculture Society and the Aquaculture Association of Canada that was held in Halifax.

1991

BIO scientists organized the summer meeting of the American Society of Limnology and Oceanography held at St. Mary's University. A catered lobster supper with entertainment was hosted one evening at BIO for all 650 delegates.
BIO scientists organized a second Halifax Inlet Research Workshop to provide a forum for the presentation and discussion of research results and plans pertaining to the inlet. In addition to scientists and managers, the audience included members of the joint federal-provincial environmental review panel that was examining the environmental implications of the proposed regional sewage treatment facility.

BIO hosted a national Workshop on the Environmental Aspects of Aquaculture that included government scientists, relevant provincial agencies and the aquaculture industry.

1992

BIO staff organized a meeting with local ocean industry companies to discuss ocean technology development and transfer.

1993

BIO scientists assisted in organizing the 124th Annual Meeting of the American Fisheries Society that was held in Halifax.

BIO hosted the seventh annual meeting of the US/Canada Joint Ice Working Group that coordinated operational ice observation and forecast activities between Canadian and US agencies.

BIO hosted a meeting of the international Ocean Observing System Development Panel that developed the design and scientific rationale for the climate module of the Global Ocean Observing System.

BIO staff organized the DFO workshop on Scotia-Fundy Groundfish Management.

1994

BIO staff assisted in the organization of international Coastal Zone Canada '94 conference that was held in Halifax and attracted 750 delegates from over fifty countries.

BIO scientists organized the Symposium on Cod and Environmental Change to review the current status groundfish, with an emphasis on cod, off the east coast of Canada.

BIO scientists assisted in the organization of the 124th Annual Meeting of the American Fisheries Society that was held in Halifax and attracted over 1000 international delegates.

1995

Hydrographers, along with several local agencies and businesses, participated in Ocean Information Technology Showcase which coincided with the G-7 Summit held in Halifax.

BIO hosted the Walter Bell Memorial Symposium on Paleobotany and Coal Science.
BIO scientists organized and led the Land Ocean Interactions in the Coastal Zone (LOICZ) international workshop to develop biogeochemical modelling guidelines that could be applied to compare the dynamics of coastal regions around the world.

BIO staff organized the second DFO workshop on Scotia-Fundy Groundfish Management.

1996

BIO scientists helped organize the Oceans Optics III conference held in Halifax.

Hydrographers helped organize the Canadian Hydrographic Conference CHC 96 held in Halifax.

1997

BIO geologists hosted a meeting of one of the international Ocean Drilling Project panels that was held concurrently with a visit of the ODP drill ship to Halifax.

BIO staff organized a DFO workshop on Science and Management Issues for Herring Management.

1998

BIO hosted an Open House.

BIO scientists helped organize and contributed to the 15th Annual Meeting of The Society for Organic Petrology held in Halifax.

BIO scientists organized the first International World Ocean Circulation Experiment (WOCE) Scientific Conference on Ocean Circulation and Climate in Halifax. This conference reviewed the initial results of the WOCE 1990-1997 field program.

BIO staff helped organize a DFO workshop on Ecosystem Considerations for Fisheries Management.

1999

Environment Canada and the Department of Fisheries and Oceans co-hosted a workshop at BIO to evaluate the potential impacts of fishing activities on seabirds in northern waters.

2000

In collaboration with the Sable Offshore Energy Environmental Effects Monitoring Advisory Group, BIO hosted a major international workshop on Understanding the Environmental Effects of Offshore Hydrocarbon Development. Attendees included government and university scientists, resource managers, regulators, industry and environmental organizations.
BIO Habitat Management staff, in partnership with the Halifax Regional Municipality, organized a workshop on Preserving the Environment of Halifax Harbour involving participants from all municipal, provincial and federal departments with regulatory and scientific responsibilities for Halifax Harbour and its watershed.

BIO hosted the Eastern Scotian Shelf Integrated Management (ESSIM) initiative workshop that defined ecosystem objectives of integrated management and discussed monitoring needs for future ocean management activities.

BIO hosted the workshop on Living Marine Resources – Global Oceans Observing System (LMR-GOOS) organized to define Canada's contribution to the living marine resources component of GOOS and focussed on defining monitoring requirements for indices supporting ecosystem objectives of integrated oceans management.

BIO scientists assisted the Nova Scotian Museum of Natural History and the Ecology Action Centre in organizing the First International Symposium on Deep-Sea Corals held in Halifax.

2001

BIO organized the second workshop on Preserving the Environment of Halifax Harbour which brought together stakeholders from three levels of government, academia, industry and public interest groups to review the state of the environment for Halifax Harbour, identify information gaps, and recommend action for the preservation and restoration of habitat and aesthetic conditions of the harbour.

BIO scientists organized the Coastal Climate Change Impacts and Adaptation Workshop bringing together coastal resource users and scientists to explore the potential impacts of climate change on coastal areas in Canada. The workshop focussed on the information and research needs of coastal communities, including coastal responses to climate change and the formulation of appropriate strategies to cope with adaptation in the face of uncertainty.

BIO scientists organized The Gully Ecosystem Review workshop to review the results of recent research and discuss how it has increased understanding of the physical and ecological boundaries and the connections between ecosystem elements of this submarine canyon.

BIO scientists organized an international *ad hoc* working group meeting held in Halifax on The Northwest Atlantic Ecosystem - A Basin Scale Approach as part of the Canadian Global Ocean Ecosystems Dynamics program. A research plan was developed to study the dynamics of *Calanus finmarchicus* in the Northwest Atlantic and how this species is affected by climatic changes in environmental conditions and circulation.

BIO staff played a leading role in the organization of CoastGIS 2001, the fourth international symposium on computer mapping and GIS for coastal zone mapping, held at Saint Mary's University. This was the first time this meeting of geomatic researchers involved in coastal zone management had been held outside Europe.

The second meeting of the international joint Scientific Steering Group for the Arctic Climate System Study and the Climate and Cryosphere projects was held at BIO discussing the high latitude climate science programs of the World Climate Research Programme.

BIO scientists organized the third meeting of the Partnership of the Observation of the Global Oceans program held at White Point Beach Lodge, NS, to discuss biological monitoring in the deep oceans and the need for fixed deep-ocean monitoring stations.

2002

BIO held a four-day Open House that attracted 35,000 to view 70 exhibits, tour ships and attend popular lectures.

To celebrate its 40th anniversary, BIO organized a symposium on Future Challenges for Marine Sciences in Canada. Twelve international speakers were invited to address diverse oceanographic research topics surrounding future challenges in oceanographic research. Symphony Nova Scotia performed a special concert in the BIO Auditorium.

BIO hosted the 4th Annual Northwest Atlantic Herring Acoustic Workshop. This international workshop brought together fisheries scientists and industry representatives to review the application of hydroacoustic techniques to herring stock assessment and management on the east coasts of Canada and the USA.

Staff from the Oceans and Coastal Management Division organized the first workshop on the Eastern Scotian Shelf Integrated Management Forum at Mount St. Vincent University intended to initiate multi-stakeholder dialogue on integrated oceans management.

BIO scientists organized a workshop on Environmental Studies for Sustainable Aquaculture to review the application of recent research on predicting the potential far-field environmental effects of salmonid aquaculture. Near-field impacts and recovery and evaluation of potential effects of toxic chemicals used in the aquaculture industry were also considered.

The Centre for Marine Biodiversity organized a workshop on Canadian Marine Biodiversity that was held at White Point Beach Lodge, NS, to discuss the current state of knowledge of marine biodiversity in Canada's three oceans and the urgent need to develop and implement effective plans for the conservation of Canada's marine biodiversity. The barcoding of species was introduced as a concept and was ultimately taken up by the Census of Marine Life.

BIO hosted the Ecological Risk Assessment Workshop to review case studies of how risk assessment has been applied to situations in the Atlantic Region.

BIO hosted the international Gulf of Maine Sewage Workshop that discussed funding mechanisms, public education, regulation and enforcement and ecosystem health.

BIO staff organized a European Union Seminar that included participants from federal government departments, provincial departments, private industry and universities with the objective of informing Canadian technology companies and researchers about opportunities for partnering with counterparts in the European Union.

BIO geologists organized a workshop to outline directions for the new NRCan Geoscience for Ocean Management Program with participants from other federal departments, the private sector, universities and the provinces.

BIO scientists assisted in organizing the Global Workshop for Assessing Operational Global Marine Environmental Prediction for Canada sponsored by the Meteorological Service of Canada and held at Dalhousie University. A major outcome was the initiation of programs to conduct marine environmental prediction on a global scale.

BIO staff assisted in the organization of the joint meeting of the Association of Earth Science Editors and the European Association of Science Editors held in Halifax. The meeting provided an opportunity for scientific editors from both sides of the Atlantic Ocean to share experiences.

2003

BIO staff organized the second Eastern Scotian Shelf Integrated Management Forum workshop held at Mount St. Vincent University to promote cross-sector dialogue and capacity building for integrated ocean management.

BIO hosted the Offshore Oil and Gas Environmental Effects Monitoring Workshop, which attracted international scientists to present and discuss monitoring approaches and technologies, environmental management issues and regional experiences. The workshop included at total of 60 oral and 19 poster presentations. A book was subsequently published containing 27 peer-reviewed research papers.

BIO hosted the Fourth International Conference on Arctic Margins.

BIO hosted the joint meeting of the Canadian Quaternary Association and the Canadian Geomorphological Research Group attracting 130 scientists from Canada, the United States, Europe and Asia.

The Centre for Offshore Oil, Gas and Energy Research hosted an Oil Dispersant Research Planning Workshop to improve decision-making, operations, planning, environmental analysis and emerging issues related to the use of chemical oil dispersants.

2004

BIO scientists organized the Environmental Studies for Sustainable Aquaculture workshop to review the results of a three-year project comparing the impacts of salmonid cage culture at study sites in Newfoundland, New Brunswick and British Columbia.

NRCan staff hosted the Geoscience for Ocean Management Workshop.

BIO staff played a leading role in organizing the second Science for Integrated Management of the Bras d'Or Lakes Progress Review workshop that was held in Whycocomagh, NS.

BIO staff assisted in the organization the Second Bras d'Or Lakes Collaborative Environmental Planning Initiative Workshop held in Wagmatcook, NS.

2005

The Oceans and Habitat Branch organized the third Eastern Scotian Shelf Integrated Management Forum workshop held in Halifax to discuss the draft plan with stakeholders.

BIO hosted the Atlantic Tsunami Warning Workshop involving federal and provincial agencies in Canada and the United States.

The Second Session of the international Joint Commission for Oceanography and Marine Meteorology program was organized with the assistance of BIO staff and held in Halifax.
BIO scientists assisted in the organization of the Joint Commission for Oceanography and Marine Meteorology Conference on Operational Oceanography and Marine Meteorology for the 21st Century that was held in Halifax.

2006

Hydrographers organized the Canadian Hydrographic Conference held in Halifax.

BIO staff helped organize the Workshop on Inshore Ecosystems and Significant Areas of the Scotian Shelf including participants from government, university, industry and NGO-supported researchers.

NRCan organized the Nova Scotia Historic Gold Mines Workshop to highlight the results of recent multidisciplinary research on the environmental effects of gold mining in Nova Scotia.

BIO hosted the annual meeting of the DFO Fisheries Oceanography Committee to compare temporal changes in ecosystem structure from the Labrador Shelf to the Gulf of Maine.

BIO helped organize a national workshop to coordinate the development of an improved atmosphere-ocean-ice prediction capability for Canada. It was held in Montreal and attended by representatives from all DFO regions, other federal agencies and universities.

A team from the European Union visited BIO to participate in an Industry Roundtable meeting discussing ecosystem approaches to fisheries management.

BIO hosted a Continuous Plankton Recorder Workshop reviewing plankton data collected by ships of opportunity in the Atlantic and Pacific Oceans.

BIO scientists organized a workshop at which the results of long-term field experiments studying the impacts of mobile fishing gear (otter trawls, hydraulic clam dredges, scallop rakes) on benthic habitat and communities were presented and discussed. The audience included fisheries and habitat managers, the fishing industry and environmental organizations.

An international conference was organized to discuss the development and application of current and emerging technologies for oil spill response in the marine environment with special attention given to the evaluation of oil spill countermeasures for use under arctic conditions.

2007

BIO hosted a five-day Open House.

BIO hosted the Six Years in the Mud workshop co-sponsored by the Ecology Action Centre, Ducks Unlimited Canada, the Nova Scotia Department of Transportation and Public Works and the Gulf of Maine Council on the Marine Environment. It stimulated a number of projects throughout the region to protect, conserve and restore salt marshes.

Hydrographers organized the Eighth Meeting of the International Hydrographic Organization Tidal Committee held at the Maritime Museum of the Atlantic in Halifax.

Geoscientists organized the Geoscience for Oceans Management Science Workshop including participants from across the country to review recent results and plan further research.
BIO hosted a meeting of the DFO Fisheries Oceanography Committee.

In collaboration with the St. Andrews Biological Station, BIO scientists organized a Workshop on Long-Range, Low-Frequency Acoustic Fish Detection to review relevant assessment questions and examine promising implementations, applicable theory, hardware specifics and environmental considerations.

In collaboration with scientists at the Northwest Atlantic Fisheries Centre, BIO scientists organized a major workshop to review and discuss the results of a five-year research program designed to investigate the spatial utilization of benthic habitat on the Scotian Shelf by demersal fish.

BIO scientists helped organize an international conference that brought together scientists, regulators, industry and non-governmental organizations to share concerns, knowledge and expertise on the discharge of produced water from operational oil and gas platforms at sea.

2008

BIO scientists were involved in organizing the International Council for the Exploration of the Sea Annual Science Meeting held in Halifax and attended by 650 delegates. It was officially opened by the Right Honourable Michaelle Jean, Governor General of Canada and provided BIO the opportunity to showcase its scientific work to an international audience.

BIO hosted the first Societal Applications in bringing together participants representing over a dozen countries to review the field of remote sensing and its application to management of sustainable fisheries and aquaculture.

BIO hosted the General Meeting of the Atlantic Canada Coastal and Estuarine Science Society, an affiliate of the Coastal and Estuarine Research Federation.

BIO hosted the sixth meeting of the Scientific Steering Group of the International Arctic-SubArctic Ocean Fluxes Study to discuss recent results in measuring and modelling the freshwater, heat and mass fluxes in the Arctic Ocean. Plans for Phase II of the study were also discussed

BIO hosted a stakeholder workshop for the Offshore Environmental Factors and Marine Transportation Safety subprograms of the federal Program on Energy Research and Development to communicate research and development results directly to those with a particular interest in offshore oil and gas issues on Canada's east coast and in the Arctic.
The Oceans and Coastal Management Division organized the fourth Eastern Scotian Shelf Integrated Management Forum held in Halifax to identify the way forward and implement the recently released plan.

2009

BIO staff organized an event to celebrate the 40th anniversary of the departure of the CSS *Hudson* on the Hudson 70 Expedition.

BIO staff assisted in the organization of the 43rd Annual Congress of the Canadian Meteorological and Oceanographic Society that was held in Halifax attracting over 550 delegates.

BIO hosted a Workshop on Arctic Freshwater Systems of the Mackenzie Delta bringing together experts to review the interactions between the Mackenzie River and the waters of the Delta and related near shore and coastal areas.

BIO scientists organized a workshop entitled United Kingdom-Canada Perturbation Experiments on Biological Response to Ocean Acidification to discuss and coordinate studies of the impacts of ocean acidification and related climate change on marine productivity.

BIO scientists organized the Offshore Environmental Factors and Marine Transportation Safety workshop held in St. John's, NL, to review the results and implications of research projects carried out under the Program on Energy, Research and Development's Frontier Oil and Gas Portfolio.

As part of the United Nations Convention on the Law of the Sea program, BIO hosted the annual international workshop entitled Scientific Issues on the Alpha-Mendeleev Ridge. Participants from Denmark, Russia, the United States and Canada provided updates on programs collecting scientific information in the Arctic Ocean for the purpose of defining the outer limits of the continental shelves.

2012

BIO hosted a five-day Open House.

As part of the 50th anniversary activities, BIO scientists organized an international Symposium on Oceans and Climate Change.

BIO staff organized a 50th Anniversary Gala Celebration event. Special guests included the Honourable Gail Shea, Minister of National Revenue and Interim Minister of Fisheries and Oceans and Ms. Karen Ellis, Assistant Deputy Minister, Natural Resources Canada.

HONOURS AND AWARDS

This section lists the many international and national awards that have been presented to BIO staff. It also includes honorary degrees, as well as the winners of the Huntsman and Beluga Awards, which are presented annually by the BIO community. Internal government awards, elected offices, invited lectures and committee memberships are not included.

1962

Dr. William E. van Steenburgh, Director-General of Scientific Services for the Department of Mines and Technical Surveys, was awarded an honorary degree by Dalhousie University for his contributions to oceanography in Canada. In his acceptance speech, Dr. van Steenburgh chronicled the events that led to the founding of BIO.

1970

Dr. George T. Needler was named a Rossby Fellow at the Woods Hole Oceanographic Institution.

1971

Capt. David Butler received an honorary degree from Brock University for his skill and seamanship in commanding the CSS *Hudson* during the Hudson 70 Expedition.

1972

The Nova Scotia Technical College awarded Dr. Cedric R. Mann the degree of Doctor of Engineering *honoris causa* for his work on the Hudson 70 cruise.

1973

Dr. Lloyd M. Dickie was elected to the Royal Society of Canada.

1974

Dr. Michael J. Keen was elected to the Royal Society of Canada.

1975

Dr. Charlotte E. Keen won the APICS/Fraser Young Scientist Medal.

1976

Dr. David N. Nettleship was elected a member of the American Ornithologists' Union.

1978

Dr. William L. Ford was awarded an honorary degree by the University of New Brunswick

Dr. David J.W. Piper won the APICS/Fraser Young Scientist Medal.

Dr. Richard G.B. Brown was elected a member of the American Ornithologists' Union.

1979

Dr. William L. Ford was awarded an honorary Doctor of Laws degree by Dalhousie University.

Dr. Peter Hacquebard was awarded the Reinhard Thiesson Medal by the International Committee of Coal Petrology and the Gilbert H. Cady Award from the Geological Society of America.

Dr. Charlotte E. Keen was awarded the Past President's Medal of the Geological Association of Canada in recognition of her contributions to the understanding of continental margins.

1980

Dr. Peter Hacquebard was awarded an honorary of Doctor of Laws degree by Dalhousie University.

Dr. Charlotte E. Keen was elected to the Royal Society of Canada.

Dr. Kenneth H. Mann was elected to the Royal Society of Canada.

The A.G. Huntsman Award was created by BIO to recognize excellence in the international marine scientific community. The award was named after Dr. Archibald Gowanlock Huntsman (1883-1973), a pioneer Canadian oceanographer and fishery biologist. In this first year, awards were given to Dr. Dan Peter McKenzie of Cambridge University, UK, for his contributions to the field of continental drift studies, Dr. Henry M. Stommel of the Woods Hole Oceanographic Institution, USA, for his contributions to understanding of the properties of major oceanic current systems, and Professor Ramon Margalef of the University of Barcelona, Spain, for his contributions to understanding processes governing the distribution of the world's oceanic plankton.

1981

The APICS/Fraser Young Scientist Medal was awarded to Dr. Trevor C. Platt.

The A.G. Huntsman Award was given to Dr. J. Tuzo Wilson of the Ontario Science Centre for his pioneering work in the field of global geology, for his contributions to the modern formation of continental drift theory and his activities introducing science to Canada's younger generations.

1982

Dr. Eric M. Levy was presented a merit award for his contributions to the Intergovernmental Oceanographic Commission's IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring.

Mr. Norman Fenerty received the William Gordon Memorial Award of the Biological Photographic Association for his outstanding achievements in scientific photography.

Dr. David N. Nettleship received the Distinguished Technical Communication Award (Books) from the Canadian Society for Technical Communication.

The A.G. Huntsman Award was given to Dr. Christopher J.R. Garrett of Dalhousie University in recognition of his contributions to the understanding of mixing processes in the ocean and for his fundamental achievements in the field of internal wave dynamics.

1983

Dr. Richard G.B. Brown received the Outdoor Writing Award from Canadian Sportmen's Shows - Outdoor Writers of Canada.

The A.G. Huntsman Award was presented to Dr. Reuben Lasker of the Southwest Fisheries Center, USA, in recognition of his fundamental contributions toward furthering understanding of the population biology of the California anchovy.

1984

Dr. Richard G.B. Brown received the Science Journalism Award from the Canadian Science Writers' Association.

Dr. William L. Ford was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. David N. Nettleship received a Service Award from the American Ornithologists' Union for exceptional assistance in the editing of the science journal *The Auk*.

Dr. Trevor C. Platt was awarded the Rosenstiel Award by the University of Miami.

Dr. Robert J. Conover, Dr. Lloyd M. Dickie and Dr. Kenneth H. Mann had published papers selected as a Citation Classic by the Science Citation Index.

Mr. Michel P. Latrémouille won the Distinguished Technical Communication Award from the Society for Technical Communication's Eastern Ontario Chapter.

The A.G. Huntsman Award was presented to Dr. Wolfgang H. Berger of the University of California, USA, in recognition of his important studies of deep-sea sediments and their chemistry.

1985

Dr. George T. Needler was elected to the Royal Society of Canada.

The A.G. Huntsman Award was presented to Dr. Wallace S. Broecker of Columbia University, USA, in recognition of his outstanding studies of geochemical processes determining concentrations of key elements and their role in the world's climate.

1986

Dr. Kenneth L. Denman was awarded the President’s Prize by the Canadian Meteorological and Oceanographic Society.

Dr. Charlotte E. Keen was elected a fellow of the American Geophysical Union.

Dr. Michael J. Keen was awarded the Logan Medal by the Geological Association of Canada.

Dr. William K.W. Li won the APICS/Fraser Young Scientist Medal.

The A.G. Huntsman Award was presented to Dr. Tom M. Fenchel of the University of Aarhus, Denmark, in recognition of his fundamental studies of microfauna in marine benthic and pelagic communities.

1987

The A.G. Huntsman Award was presented to Prof. Xavier Le Pichon of the École normale supérieure, France, in recognition of his leadership and analytical skill in the formulation and application of the principles of plate tectonics.

1988

Dr. Alan R. Longhurst was elected to the Royal Society of Canada.

Dr. Trevor C. Platt was awarded the Evelyn Hutchinson Award by the American Society of Limnology and Oceanography.

The A.G. Huntsman Award was presented to Prof. Carl Wunsch of the Massachusetts Institute of Technology, USA, in recognition of his contributions to developing new global perspectives of the oceans and their integration into the global climate system.

1989

Dr. David N. Nettleship was elected a Fellow of the American Ornithologists’ Union.

The A.G. Huntsman Award was presented to Dr. Lawrence R. Pomeroy of the University of Georgia, USA, for his contributions to broadening knowledge of the role of bacteria in oceanic food chains.

1990

Dr. Peta J. Mudie was elected to the Royal Society of Canada.

Dr. Trevor C. Platt was elected to the Royal Society of Canada.

The A.G. Huntsman Award was presented to Dr. Nicholas J. Shackleton of Cambridge University, UK, in recognition of his innovative work on paleoceanography and the development of oxygen isotopic stratigraphy.

1991

Dr. Alan R. Longhurst was awarded the 1991 Gold Medal by the Professional Institute of the Public Service of Canada.

Dr. Lloyd M. Dickie was presented the Oscar Sette Memorial Award by the American Fisheries Society.

Dr. Stuart D. Smith was awarded the 1991 American Meteorological Society's Editor's Award.

Dr. Daniel G. Wright was awarded the President's Prize by the Canadian Meteorological and Oceanographic Society.

Dr. Daniel G. Wright received the Excellence in Reviewing Award from the Canadian Meteorological and Oceanographic Society.

The A.G. Huntsman Award was presented to Dr. Gabriel T. Csanady of Old Dominion University, USA, in recognition of his fundamental contributions to the understanding of circulation and mixing on the continental shelf and in lakes.

1992

Dr. Charlotte E. Keen was awarded honorary membership of the Canadian Society of Exploration Geophysicists.

Dr. Fred W. Dobson was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Lubomir Jansa was awarded the Professor Purkyne Medal by the Czechoslovakia Geological Survey.

Drs. Kenneth H. Mann and John R.N. Lazier won a Government of Canada Merit Award for their book *Dynamics of Marine Ecosystems: Biological-Physical Interactions in the Oceans*.

Dr. Gustav Vilks was awarded honorary membership to the North American Micropalaeontology Section of the Society for Sedimentary Geology.

The A.G. Huntsman Award was given to Dr. Trevor C. Platt of BIO in recognition of his fundamental and wide-ranging research into the functioning of pelagic ecosystems, especially of the open ocean and critical computations of global oceanic algal productivity.

1993

Dr. Rob A. Fensome and Dr. Graham L. Williams received the Golden Trilobite Award from the Paleontological Association.

Dr. Charlotte E. Keen was awarded the Michael J. Keen Medal by the Marine Geosciences Division of the Geological Association of Canada.

Dr. Cedric R. Mann was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

The A.G. Huntsman Award was presented to Dr. Robert A. Berner of Yale University, USA, in recognition of his research on mathematical modelling of kinetics transforming sedimentary geochemistry from a descriptive science to one of prediction and quantitative understanding.

1994

A submarine canyon on the edge of the Grand Banks off Newfoundland was named in honour of the late Dr. Michael J. Keen.

Dr. Kenneth L. Drinkwater was awarded the François J. Saucier Prize in Applied Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Lubomir Jansa was awarded the Georgius Agricola Medal by the Mining and Metallurgic University of Czechoslovakia and the Masaryk Medal by Masaryk University, Czechoslovakia.

Dr. E. Peter Jones was awarded the degree of Doctor Honoris Causa by the University of Göteborg, Sweden.

Dr. Charlotte E. Keen was awarded the George P. Wollard Award by the Geological Society of America.

Dr. Lewis H. King was awarded the Michael J. Keen Medal by the Marine Geosciences Division of the Geological Association of Canada.

Dr. Kenneth H. Mann was the first recipient of the American Society of Limnology and Oceanography Lifetime Achievement Award.

The A.G. Huntsman Award was presented to Dr. Edward A. Boyle of the Massachusetts Institute of Technology, USA, in recognition of his fundamental work and leadership in developing the use trace metals in foraminifera shells to retrieve historical data on nutrients, productivity and deep-water circulation of the oceans.

1995

Dr. Peter Hacquebard was the first winner of the Walter Bell Silver Medal.

Dr. Peter Hacquebard was presented with the John Costano Honorary Award of the Society for Organic Petrology.

Dr. Charlotte E. Keen was presented with the J. Tuzo Wilson Medal by the Canadian Geophysical Union.

Dr. Charlotte E. Keen was elected a distinguished fellow of the Geological Association of Canada.

The A.G. Huntsman Award was presented to Dr. Victor S. Smetacek of the Alfred Wegner Institute, Germany, in recognition of his fundamental and visionary contributions to the biogeochemistry of the ocean water column and its associated sediments in temperate and polar ecosystems.

1996

Dr. Graham L. Williams was awarded the annual E.R. Ward Neale Medal of the Geological Association of Canada and the American Association of Stratigraphic Palynology Medal for Scientific Excellence.

Mr. Steve M. Blasco received the H.G. Hamilton Award from Queen's University.

Dr. John R.N. Lazier was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Stuart D. Smith was awarded the President's Prize by the Canadian Meteorological and Oceanographic Society.

The A.G. Huntsman Award was presented to Dr. Robert Detrick of the Woods Hole Oceanographic Institution, USA, in recognition of his fundamental and pioneering contributions to our understanding of the genesis and evolution of oceanic lithosphere.

1997

Dr. Alan R. Longhurst was presented with the American Society of Limnology and Oceanography Lifetime Achievement Award.

Dr. Alan C. Grant was awarded the Michael J. Keen Medal by the Marine Geosciences Division of the Geological Association of Canada.

The A.G. Huntsman Award was presented to Dr. Russ E. Davis of the University of California, USA, in recognition of his fundamental contributions to the understanding of Lagrangian circulation dynamics, including instrumentation development, observational programs and theoretical studies.

1998

Dr. R. Allyn Clarke was awarded the Government of Canada Award of Excellence by the President of the Treasury Board.

Dr. Lubomir Jansa was elected a Fellow of the Geological Society of America.

Dr. Neil S. Oakey was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Peter C. Smith, Dr. David A. Greenberg, Dr. Donald J. Lawrence, Dr. Guoqi Han, Ms. Jennifer Shore, Dr. John W. Loder, Dr. Charles G. Hannah, Mr. Roger Pettipas and Mr. Brendon De Tracey were awarded the François J. Saucier Prize in Applied Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Trevor C. Platt was elected to the Fellowship of the Royal Society of London.

Dr. David N. Nettleship received the Committee on the Status of Endangered Wildlife in Canada Service Award.

The A.G. Huntsman Award was presented to Dr. Paul Falkowski of Rutgers University, USA, in recognition of his fundamental contributions to a broad spectrum of ocean sciences, from pico-second molecular biophysics to the billion-year evolution of ocean-atmosphere biogeochemistry.

1999

Dr. David J.W. Piper was awarded the Michael J. Keen Medal by the Marine Geosciences Division of the Geological Association of Canada.

The A.G. Huntsman Award was presented to Prof. I. Nicholas McCave of Cambridge University, UK, in recognition of his outstanding contributions to understanding the dynamics of fine sediments in a diversity of marine environments, ranging from the near shore to the deep sea.

2000

Dr. Richard G.B. Brown received a Lifetime Achievement Award from the Pacific Seabird Group.

Dr. David J.W. Piper was awarded the Gesner Medal by the Atlantic Geoscience Society.

Dr. Peter G. Wells was elected a Fellow of the American Association for the Advancement of Science.

The A.G. Huntsman Award was presented to Dr. William Jenkins of the Southampton Oceanography Centre, UK, in recognition of his important contributions to the development of the tritium-helium dating technique and its application to studies of ocean circulation, mixing and productivity.

2001

Mr. Steve M. Blasco was elected to the Order of Canada to honour his contributions to marine geosciences in Canada. This was the first such award made to a BIO scientist.

Dr. Richard A. Pickrill, Mr. Les Burke, Mr. J. Richard MacDougall, Commander James Bradford and Dr. Kate Moran were presented an award by the Nova Scotia Federal Council for their work in implementing the SeaMap initiative and enhancing interdepartmental relationships.

Dr. R. Allyn Clarke was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Donald C. Gordon was presented the 5NR Science Award to Leaders in Sustainable Development which pays tribute to outstanding contributions by federal scientists contributing to sound management decisions affecting the sustainability of marine resources.

The A.G. Huntsman Award was presented to Dr. David M. Karl of the University of Hawaii, USA, in recognition of his fundamental contributions to improved understanding of the biochemistry, microbiology and genomics of ocean ecosystems and their role in global processes.

The Beluga Award was created by the Bedford Institute of Oceanography-Oceans Association to recognize outstanding contributions to the BIO community. The first award was presented to Mr. Roger Belanger to honour his photographic technology and art.

2002

Ms. Jennifer Bates, Dr. Rob A. Fensome and Dr. Graham L. Williams received the Best Publication of the Year Award from the Association of Earth Science Editors.

Dr. Rob A. Fensome and Dr. Graham L. Williams received the Distinguished Service Award from the Atlantic Geoscience Society.

Dr. Donald L. Forbes received the Government of Canada 5NR Science Award to Leaders in Sustainable Development.

Dr. Peta J. Mudie was awarded an Honorary Research Fellowship, University of Glasgow.

Dr. R. Allyn Clarke received an Editor's Citation for Excellence in Reviewing by the American Geophysical Union at their spring meeting in 2002.

Dr. René Lavoie received the Honorary Lifetime Achievement Award from the Aquaculture Association of Canada.

The A.G. Huntsman Award was presented to Dr. Donald W. Forsyth of Brown University, USA, in recognition of his outstanding contributions to understanding oceanic crustal structure and mantle dynamics.

The BIO-OA Beluga Award was presented to Mr. Peter Vass.

2003

Mr. Steve M. Blasco received an Award of Excellence from Parks Canada.

Dr. Charlotte E. Keen was awarded an honorary doctoral degree by Dalhousie University.

The Gulf of Maine Council Visionary Award for Nova Scotia was presented to Dr. Kenneth H. Mann for his outstanding contribution to the understanding of the coastal ecosystems of the northwest Atlantic Ocean.

Dr. Graham L. Williams received the Canpolar Sciences Communications Award in recognition of his leadership in the publication of *The Last Billion Years: a Geological History of the Maritime Provinces.*

The A.G. Huntsman Award was presented to Dr. Lynne D. Talley of the Scripps Institution of Oceanography, USA, in recognition of her outstanding contributions to the description and understanding of the circulation and ventilation of the global ocean.

The BIO-OA Beluga Award was presented to Mr. Arthur Cosgrove.

2004

Dr. Alan C. Grant was awarded the Gesner Medal by the Atlantic Geoscience Society.

Dr. Brian D. Petrie was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

Dr. Steven E. Campana was presented with the Lifetime Achievement Award at the Third International Symposium on Fish Otolith Research and Application.

Dr. Kenneth Lee received the Federal Partners in Technology Transfer (FPTT) Award for his leadership in the development and transfer of innovative technologies and strategies to alleviate the damage of oil spills and enhance recovery of the natural habitat.

There was no Huntsman Award this year.

The BIO-OA Beluga Award was presented to Dr. David L. McKeown.

2005

Mr. R. Michael Eaton was elected a member of the Order of Canada in recognition of his contributions to the development of electronic navigation charts.

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Dr. Alan C. Grant was awarded the R.J.W. Douglas Medal by the Canadian Society of Petroleum Geologists.

Dr. Daniel M. Ware won the Timothy R. Parsons Award of Fisheries and Oceans Canada for excellence in ocean sciences.

This year was the 25th anniversary of the A.G. Huntsman Award and to mark the occasion four awards were given. Dr. Sallie W. Chisholm of the Massachusetts Institute of Technology, USA, was honoured for her insightful contributions to the fields of biological oceanography and microbial ecology which fundamentally changed our perspective of the nature of life in the sea. Dr. Edouard Bard of the Collége de France, France, was honoured for his significant contributions to isotopic dating and proxy thermometry techniques and their application to studies of the Earth's paleoclimate and, in particular, its ice-age climate and sea level dynamics. Dr. Trevor J. McDougall of the Commonwealth Scientific and Industrial Research Organization, Australia, was honoured for his leading role in developing a practical understanding of important thermodynamic and dynamic processes in the ocean which are a key to the mixing motions that strongly influence ocean circulation and heat transport. And finally, Dr. Robert F. Anderson of Columbia University, USA, was honoured for his innovative contributions in the fields of biochemical cycles, ocean sedimentation and climate variability through his development and use of radioisotope tracers.

The BIO-OA Beluga Award was presented to Ms. Jackie Dale in recognition of her many and diverse contributions to the BIO community.

2006

Dr. Graham L. Williams was awarded the J. Willis Ambrose Medal by the Geological Association of Canada.

Dr. Alan C. Grant was awarded an Honorary Doctor of Laws degree by Dalhousie University in recognition of his contributions to understanding of sedimentary geology in Canada.

Dr. Trevor C. Platt and Dr. Kenneth L. Denman won the Timothy R. Parsons Award of Fisheries and Oceans Canada for excellence in ocean sciences.

Dr. David N. Nettleship was awarded a Certificate of Appreciation as a Founding Member of the Birds Specialist Subcommittee and for three decades of service from the Committee on the Status of Endangered Wildlife in Canada.

There was no Huntsman Award this year.

The BIO-OA Beluga Award was presented to Capt. Joseph Bray for his dedication and professionalism over many years in support of BIO's research program.

2007

Dr. David J.W. Piper received a Special Award from the International Association of Sedimentologists.

Dr. Donald L. Forbes, Dr. R. Allyn Clark, Dr. Trevor C. Platt and Dr. Igor Yashayaev were among those honoured for their contributions to the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC). The IPCC shared the 2007 Nobel Peace Prize with former US Vice-President Al Gore for their efforts to build up and disseminate greater knowledge about climate change, and to lay the foundations for the measures that are needed to counteract such change.

Dr. Simon J. Prinsenberg was the recipient of the 2007 J.P. Tully Medal in Oceanography of the Canadian Meteorological and Oceanographic Society.

The Canadian Meteorological and Oceanographic Society conferred the title of CMOS Fellow on Dr. R. Allyn Clark in recognition of his major contributions to the physical oceanography of the North Atlantic and to global climate studies through research, management, and leadership at both national and international levels.

Dr. C.F. Michael Lewis was awarded the Michael J. Keen Medal by the Marine Geoscience Division of the Geological Association of Canada.

The A.G. Huntsman Award was presented to Dr. Thomas Kiørboe of the Danish Institute for Fisheries Research, Denmark, in recognition of his original and provocative thinking leading to pioneering contributions in many areas of marine ecology, particularly in linking individual and small scale processes to observed patterns in populations and communities.

The BIO-OA Beluga Award was presented to Mr. Murray Scotney.

2008

Mr. Gerard Costello, Mr. Michael Lamplugh, Dr. Bob Courtney, Dr. Vladimir Kostylev, Dr. Richard A. Pickrill and Dr. Brian J. Todd received the Excellence in Technology Transfer Award from the Federal Partners in Technology Transfer.

Dr. Donald C. Gordon was awarded Timothy R. Parsons Award of Fisheries and Oceans Canada for excellence in ocean sciences.

The A.G. Huntsman Award was presented to Dr. Roger François of the University of British Columbia in recognition of his ground-breaking research in marine geochemistry centered at the intersection of physical, chemical and biological processes, thereby influencing our understanding of climate-related changes in ocean circulation and ocean chemistry.

The BIO-OA Beluga Award was presented to Mr. Borden Chapman.

2009

The A.G. Huntsman Award was given to Dr. James P.M. Syvitsky of the University of Colorado, Boulder, CO for his exceptional contributions to understanding fjords, rivers, deltas, estuaries, particle dynamics, simulation of sediment transport and stratigraphy, continental margin sedimentation, gravity flows, and animal-sediment interactions. Dr.Syvitsky worked in BIO from 1981 to 1995.

The BIO-OA Beluga Award was presented to Mr. Bruce Anderson

2010

Mr. Steve M. Blasco received the Distinguished Merit Award of the Government of Canada for communicating science to northern communities.

Dr. Felix Gradstein was awarded the Jean Baptiste Lamark Medal by the European Geosciences Union.

Dr. Brian D. Petrie was awarded the Timothy R. Parsons Award of Fisheries and Oceans Canada for excellence in ocean sciences.

Dr. David J.W. Piper was awarded the Shepard Medal by the Society for Sedimentary Geology.

The A.G. Huntsman Award was presented to Dr. Curtis A. Suttle of the University of British Columbia, Vancouver, BC, for his ground-breaking work in launching the field of marine virology and demonstrating that viruses are the most abundant and genetically diverse organisms in the World's oceans.

The BIO-OA Beluga Award was presented to Dr. Sherry Nevin.

2011

Mr. Steve M. Blasco received the Distinguished Merit Award of the Government of Canada for achievement in the synthesis of Beaufort Sea seabed geohazard research.

Dr. R. Allyn Clarke was awarded an Intergovernmental Oceanographic Commission 50th Anniversary Commemorative Medal.

Dr. Rob A. Fensome received a Lifetime Achievement Award for work on dinoflagellates at the DINO9 meeting at Liverpool, UK.

Dr. Donald L. Forbes received an Award for Geography in the Service of Government from the Canadian Association of Geographers.

Dr. Kenneth Lee was awarded a Discovery Centre Award for Professional Distinction.

Dr. John W. Loder was awarded the J.P. Tully Medal in Oceanography of the Canadian Meteorological and Oceanographic Society.

Dr. Graham L. Williams was awarded the Billings Medal of the Geological Association of Canada

The A.G. Huntsman Award was presented to Dr. Andrew J. Weaver of the University of Victoria, Victoria, BC, for his leadership and contributions to ocean and climate variability modelling and analysis.

The BIO-OA Beluga Award was presented to Mr. Brian Beanlands.

2012

Dr. David J.W. Piper was awarded an honorary degree by the University of Athens.

The A.G. Huntsman Award was presented to Dr. Katrina J. Edwards of the University of Southern California for her research on reciprocal interactions between microbes and minerals on the ocean floor and how these processes influence global biogeochemical processes.

The BIO-OA Beluga Award was presented to Dr. Donald C. Gordon.

PROMINENT VISITORS

This section lists some of the many elected officials, distinguished scientists, scientific delegations and Royalty that have visited BIO. Many notable visitors were missed because they were not recorded in the Annual and Biennial Reviews, especially in the early years. For many years, a visitor's book was kept in the director's office but this later disappeared and could not be found.

1962

- The Honourable Paul Martineau, Minister of the Department of Mines and Technical Surveys
- Dr. J. L. Kask, Chairman of the Fisheries Research Board of Canada
- The Honourable Robert L. Stanfield, Premier of Nova Scotia

1967

- The Honourable Jean-Luc Pépin, Minister of the Department of Energy, Mines and Resources
- The Honourable Robert L. Stanfield, Premier of Nova Scotia
- Twenty-seven members of the Science Council of Canada, chaired by Dr. O. M. Solandt
- A party of six from the USSR Ministry of Fisheries including Mr. A. A. Ischkov, Dr. A. S. Bogdanov and Dr. S. A. Studenetsky

1968

- The Right Honourable Roland Michener, Governor-General of Canada
- Dr. Hely G. Neuymin of the Marine Hydrophysical Institute of the Ukrainian Academy of Sciences and some forty scientific staff from RN *Lomonosov* when this noted Russian research ship paid a visit to Halifax.

1969

- Members of the House of Commons Standing Committee on External Affairs
- Members of the House of Commons Standing Committee on National Defence

1970

- The Honourable J.J. Greene, Minister of Energy, Mines and Resources
- Mr. Adolph W. Schmidt, Ambassador of the United States of America
- His Excellency Boris Miroshnichenko, Ambassador of the Union of Soviet Socialist Republics
- Monsieur R. C. Chauvin, Director, Centre Océanologie de Bretagne, France
- Rear Admiral G.S. Ritchie, Hydrographer of the Royal Navy
- Dr. G. Grasshof, Institute für Meerskunde, Germany
- Dr. Erhhi Polosuv, Institute of Marine Research, Finland
- Dr. Allan Bé, Lamont-Doherty Geological Observatory
- Dr. Bostwick H. Ketchum, Associate Director, Woods Hole Oceanographic Institution
- Dr. C.C. Bates, Chief Scientist, United States Coast Guard

- Dr. Panteleev and party on the occasion of the visit to Halifax of the RV *Akademik Vernadsky*
- The Parliamentary Committee on National Resources and Public Works

1972

- The Honourable Jack Davis, Minister of the Environment and Fisheries
- The Honourable Alastair W. Gillespie, Minister of State for Science and Technology
- The Honourable Donald McDonald, Minister of Energy, Mines and Resources
- The Honourable Robert Stanbury, Minister of Communications,
- Sir Peter Hayman, the British High Commissioner
- Mr. Adolph W. Schmidt, Ambassador of the United States of America
- Dr. Colm OhEocha, Chairman of the National Science Council of Eire
- Mr. M. J. Farre and Mr. M. J. Rocket, French Petroleum Institute
- Dr. Kurt Lillelund, Director, Institute of Hydrobiology and Fisheries Research, Germany
- Dr. Amann, Chief, Department of Maritime Technik, Germany
- Professor P. Welander, University of Göteborg, Sweden
- Professor Walden, German Hydrographic Services, Germany
- Dr. Hanato Tsuraga, Tokai Regional Fisheries Laboratory, Japan
- Dr. J. P. Staubo, Royal Norwegian Council for Scientific and Industrial Research, Norway
- Dr. Lars Emmelin, University of Lund, Sweden;
- Mr. Chiao Li-jen, Ministry of Fuel and Chemical Industries, China
- Mr. Sun Chen-ming, Revolutionary Committee of the Taching Oil Field, China
- Dr. N. A. Ostenso, Deputy Director, US Office of Naval Research
- Dr. L. J. L'Heureux, Chairman, Defence Research Board
- Dr. P. D. McTaggart-Cowan, Executive Director, Science Council of Canada
- Dr. W. G. Schneider, President, National Research Council of Canada
- Members of the National Research Council
- Professor Tuzo Wilson, Principal, Erindale College, University of Toronto.

1974

- Dr. J.R. Weir, Chairman of the Fisheries Research Board
- Sir George Deacon, Director Emeritus, Institute of Ocean Sciences, UK
- The Honourable Jeanne Sauvé, Minister of State for Science and Technology
- Dr. David F. Downing, British High Commission to Canada
- Dr. Hans Walden, Deutches Hydrographisches Institüt, Germany
- Rear Admiral D. S. Boyle, Maritime Command, Royal Canadian Navy
- Dr. S. S. Vogt, Institute of Oceanology, Academy of Sciences, USSR
- Mr. E. S. Bobrov, Counsellor of the USSR Embassy in Ottawa
- Dr. Boyd E. Olson, US Naval Oceanographic Office, National Oceanic and Atmospheric Administration
- Dr. Charles C. Bates and party, US Coast Guard, Research and Development,
- Dr. Harold E. Edgerton, Massachusetts Institute of Technology
- Admiral V. D. Shandabilov, Hydrographic Office, USSR

- Dr. N. R. Pannikar, National Oceanographic Institute, India

1976

- A Chinese fisheries delegation led by Mr. Hsiao Feng, Director, Aquatic Products Bureau, Ministry of Agriculture and Forestry, China
- Dr. J.B. Hersey, Deputy Assistant Oceanographer for Ocean Science, Office of Naval Research, USA
- Mr. H.H. Haunschild, Deputy Minister of Research and Technology, Germany
- Professor A.P. Kapitsa, Chairman of the Far Eastern Scientific Centre, USSR.

1980

- Jacques Yves Cousteau
- The Honourable Roméo LeBlanc, Minister of the Department of Fisheries and Oceans
- The Honourable Judy Erola, Minister of the State of Mines, Department of Energy, Mines, and Resources
- The Honourable John Shaffner, Lieutenant-Governor of Nova Scotia
- Dr. Ramon Margalef, University of Barcelona, Spain.
- Dr. Henry M. Stommel, Woods Hole Oceanographic Institution, USA
- Dr. Dan Peter McKenzie, University of Cambridge, UK

1981

- The Honourable John Shaffner, Lieutenant-Governor of Nova Scotia
- Dr. Hendrik Postma, Director of the Netherlands Institute of Sea Research
- Dr. J. Tuzo Wilson, Ontario Science Center, Toronto, ON

1982

- His Excellency, Governor General Edward Schreyer
- The Honourable John Shaffner, Lieutenant-Governor of Nova Scotia
- The Honourable Roméo Le Blanc, Minister of Fisheries and Oceans
- The Honourable Pierre De Bané, Minister of Fisheries and Oceans
- Attendees at the Joint Oceanographic Assembly 1982 held in Halifax
- Dr. Christopher J.R. Garrett, Dalhousie University, Halifax, NS

1983

- The Honourable John Shaffner, Lieutenant-Governor of Nova Scotia
- Dr. Reuben Lasker, Southwest Fisheries Center, USA

1984

- President Eanes of Portugal and his Ministers for Affairs and Sea and Foreign Trade
- The Canada-United States Military Cooperation Committee
- Dr. Kathryn Sullivan, a mission specialist on NASA's 1984 shuttle flight 41G
- The Honourable Alan Abraham, Lieutenant-Governor of Nova Scotia
- Dr. Terence Armstrong of the Scott Polar Research Institute, UK
- Mr. Christopher Trump, Vice President of SPAR Aerospace Company

- Professor Wolfgang Krauss, Institut für Meereskunde, Germany
- Captain A. Civetta, Chief Hydrographer of the Italian Navy with his staff and the Italian military attaché
- Dr. Warren Godson, Senior Science Advisor with the Atmospheric Environment Service
- Dr. Andrew G. Carey, Jr., Oregon State University
- Professor Yoshiaki Toba of the Geophysical Institute of Tohoku University, Japan
- Dr. Wolfgang H. Berger, University of California, USA

1985

- The Honourable Alan Abraham, Lieutenant-Governor of Nova Scotia
- Dr. Wallace S. Broecker, Columbia University, USA

1986

- The Honourable Alan Abraham, Lieutenant-Governor of Nova Scotia
- Dr. Tom M. Fenchel, University of Aarhus, Denmark.

1987

- The Honourable Alan Abraham, Lieutenant-Governor of Nova Scotia
- A People's Republic of China delegation in the marine sciences and ocean resources field led by His Excellency Yang Jun, Special Advisor to the State Council for Science and Technology and Deputy Head of the State Council Leading Group for Ocean Resources.
- The Honourable John Buchanan, Premier of Nova Scotia
- Dr. John Savage, Mayor of Dartmouth
- Mr. Ron Wallace, Mayor of Halifax
- The Honourable Michael Forrestall, Member of Parliament
- Dr. Peter Meyboom, Deputy Minister of Fisheries and Oceans
- Associate Deputy Minister of the Department of Energy, Mines and Resources
- Vice President, Academic Research, Dalhousie University
- Dr. Xavier LePichon. École normale supérieure, France

1988

- The Senate of Canada's Standing Committee on Fisheries
- The Honourable Alan Abraham, Lieutenant-Governor of Nova Scotia
- The Senate of Canada Standing Committee on Fisheries
- Dr. Byong-Kwon Park, Director of the Korean Ocean Research and Development Institute
- Members of the Brander-Smith Public Review Panel on Tanker Safety
- Dr. John Woods, Director of Marine Sciences, Natural Environment Research Council, U.K.
- Dr. Carl Wunsch, Massachusetts Institute of Technology, USA

1989

- Dr. Lawrence R. Pomeroy, University of Georgia, USA

1990

- The Honourable Lloyd Crouse, Lieutenant-Governor of Nova Scotia
- The House of Commons Standing Committee on Industry, Science, and Technology
- The Engineering Committee on Oceanic Resources on the occasion of its 1990 General Assembly and Council Meeting
- Dr. Nicholas J. Shackleton, University of Cambridge, UK

1991

- The Honourable Lloyd Crouse, Lieutenant-Governor of Nova Scotia
- The Select Committee on Energy and Processing of Resources of the Legislative Assembly of Western Australia
- The Minister of Fisheries of the former USSR
- Dr. R. K. Steedman, Chairman-Designate of the Australian Institute of Marine Science
- M. Pierre Papon, President of the French Research Institute for Exploitation of the Sea, France
- The Canadian Commission for the United Nations Educational, Scientific and Cultural Organization
- Members of the Japan Marine Science and Technology Centre
- Dr. Gabriel T. Csanady, Old Dominion University, USA

1992

- The Ministers of Agriculture and Fisheries and Commerce and Industry from the Sultanate of Oman
- Dr. John Savage, Premier of Nova Scotia
- The French Ambassador to Canada
- The Honourable Lloyd Crouse, Lieutenant-Governor of Nova Scotia

1993

- The Honourable Lloyd Crouse, Lieutenant-Governor of Nova Scotia
- Her Royal Highness Princess Chulabhom of Thailand
- Prof. Lauro Barcelles, Director of the Museum of Oceanography, Brazil;
- His Excellency Baron de Vos van Stenwijk, The Netherlands Ambassador to Canada
- Dr. Gunnar Kullenberg, Secretary, Intergovernmental Oceanographic Commission of UNESCO
- Dr. Lucien Laubier, Director of International Relations and Cooperation of the French Research Institute for Exploitation of the Sea, France
- Dr. Robert A. Berner, Yale University, USA

1994

- The Honourable Stan Dromisky, Member of Parliament for discussions on the Canadian Environmental Protection Act
- The Honourable James Kinley, Lieutenant-Governor of Nova Scotia
- Vice-Admiral Jose Sarmento Gouveia, Portuguese Hydrographer, Portugal

- Dr. Max M. Tilzer, Director, Alfred Wegener Institute for Polar and Northern Research, Germany
- Rear-Admiral Gamett, Commander of Maritime Forces Atlantic
- Dr. Edward A. Boyle, Massachusetts Institute of Technology, USA

1995

- The wife of Russian President Boris Yeltsin paid a private visit to BIO during the G7 Summit meetings in Halifax.
- The Honourable James Kinley, Lieutenant-Governor of Nova Scotia
- A party of 13 fisheries scientists from Indonesia
- Prof. T.J. Lam, Department of Zoology, National University of Singapore, Singapore
- Dr. Victor S. Smetacek, Alfred Wegener Institute, Germany

1996

- Mr. Fred Woodman, Chair of the Fisheries Resources Conservation Council
- Twenty Fellows from the Center of International Affairs, Harvard University, USA
- The Honourable James Kinley, Lieutenant-Governor of Nova Scotia
- Dr. Robert Detrick, Woods Hole Oceanographic Institution, USA

1997

- His Royal Highness, Prince Phillip chaired a World Wildlife Fund Workshop at BIO on Endangered Species
- The Honourable David Anderson, Minister of the Department of Fisheries and Oceans
- The Honourable Gilbert Normand, Member of Parliament and Secretary of State for Fisheries & Oceans and Agriculture and Agri Food
- The Honourable James Kinley, Lieutenant-Governor of Nova Scotia
- Dr. Russ E. Davis, University of California, USA

1998

- The Honourable James Kinley, Lieutenant-Governor of Nova Scotia
- Dr. Paul Falkowski, Rutgers University, USA

1999

- The President of Iceland, Mr. Olafur Ragnar Grimsson
- Ms. Siv Fridleifsdottir, Minister for the Environment and Nordic Cooperation, Iceland
- The Honourable James Kinley, Lieutenant-Governor of Nova Scotia
- Dr. Nicholas McCave, University of Cambridge, UK

2000

- The Honourable Herb Dhaliwal, Minister of the Department of Fisheries and Oceans
- Mel Cappe, Clerk of the Privy Council
- The Honourable Myra Freeman, Lieutenant-Governor of Nova Scotia
- Dr. Howard Alper, President of the Academy of Science of the Royal Society of Canada
- Dr. William Jenkins, Southampton Oceanography Centre, UK

2001

- Paul Kennedy, host of CBC Radio's *Ideas* program, visited BIO to talk with staff about ideas for a radio program titled *Oceans Exploration 2001: Learning from our Oceans.*
- Dr. David Karl, University of Hawaii, USA

2002

- The Honourable Robert G.Thibault, Minister of Fisheries and Oceans
- The Honourable Herb Dhaliwal, Minister of Natural Resources Canada
- The Honourable David Anderson, Minister of the Environment
- Dr. David Suzuki
- Dr. Peter Harrison, Deputy Minister of Fisheries and Oceans
- Mr. George Anderson, Deputy Minister of Natural Resources Canada
- Mr. Jean-Claude Bouchard, Associate Deputy Minster of Fisheries and Oceans
- Dr. Jean-Francois Minster, President of the French Research Institute for Exploration of the Sea, France
- A 14-member Chinese delegation led by Mr. Wang Yanliang, President of the Chinese Academy of Fishery Science
- The Indonesian Ambassador to Canada and an Indonesian delegation of senior officials
- Dr. Donald W. Forsyth, Brown University, USA

2003

- Mr. Larry Murray, Deputy Minister of Fisheries and Oceans
- Mr. Jorgen Holinquist, Science Director-General with the European Union
- The Honourable Robert Thibault, Minister of Fisheries and Oceans
- Mr. Fan Fengxin, Mr. Chen Changan, and Mr. Wang Weiyuan from the Chinese Academy of Science
- Seven government leaders from Nigeria to learn about the science knowledge necessary for supporting their UNCLOS claim
- Dr. Lynne Talley, Scripps Institution of Oceanography, USA

2004

- Admiral Glen Davidson, Commander of Maritime Command, Atlantic
- The Honourable Reg Alcock, Minister of Public Works and Government Services
- The Honourable Geoff Regan, Minister of Fisheries and Oceans
- Mr. Leonard Hill, US Consul General in Halifax

2005

- Derek Hatfield who single-handedly sailed the *Spirit of Canada* more than 28,700 nautical miles in a race around the world
- A group of 15 Foreign Service Officers from the Department of Foreign Affairs
- Ms. Odile Jouanneau, wife of the French ambassador to Canada and a project engineer with the Centre national de la recherche scientifique
- Mr. Jean Sarrazin, Advisor for Science and Technology at the French Embassy in Ottawa
- Ms. Claire LaPeyne, the cultural attaché with the French General Consulate in Moncton and Halifax

- Dr. Derek Jackson, Director of the Centre of Coastal and Marine Research at the University of Ulster, Ireland
- Dr. Peter Harrison, Senior Researcher at the National Research Council of Canada and former Deputy Minister of DFO
- Dr. Arthur Carty, National Science Advisor to the Prime Minister of Canada
- Dr. Joe Borg, the European Union Commissioner of Fisheries
- Mr. John Richardson, the Director General of the EU directorate responsible for ocean activities
- Ms. Lucie McClung, DFO Associate Deputy Minister
- Dr. Trevor J. McDougall, Commonwealth Scientific and Industrial Research Organization, Australia.
- Dr. Edouard Bard, Université d'Aix-Marseille and Collège de France, France.
- Dr. Sallie (Penny) W. Chisholm, Massachusetts Institute of Technology, USA
- Dr. Robert Anderson, Columbia University, USA

2006

- Representatives of the Northern Ireland Fish Producers Organization
- Peter Stoffer, Member of Parliament for Sackville and Eastern Shore
- A diplomatic delegation from Kenya

2007

- The First Nations and Inuit Science Youth Camp organized by Indian and Northern Affairs Canada as a means to engage First Nations youth in science
- A delegation from the Kenyan Ministry of Livestock and Fisheries headed by Mr. Bernard Ayugu
- Dr. Thomas Kiørboe, Danish Institute of Fisheries Research, Denmark.

2008

- Kevin Lynch, Clerk of Privy Council
- Dr. Johann Sigurjonsson, the Director of the Marine Research Institute of Iceland
- A delegation of scientists from the French Research Institute for Exploitation of the Sea, France
- Dr. Roger François, University of British Columbia, BC

2009

- A group of students from the Marine Environment and Ocean Management program at the World Maritime University in Sweden led by Mr. Neil Bellefontaine, former Regional Director-General
- Professor François Primeau of the University of California, USA
- A delegation of Spanish oceanographers, industry representatives, and government officials to explore potential collaboration in ocean science
- Dr. James P.M. Syvitski, University of Colorado, USA

2010

- Her Majesty Queen Elizabeth II and Prince Philip

- Dr. Curtis A. Suttle, University of British Columbia, BC.

2011

- Dr. Andrew J. Weaver, University of Victoria, BC.

2012

- The Honourable Gail Shea, Minister of National Revenue and Interim Minister of Fisheries and Oceans
- Karen Ellis, Assistant Deputy Minister, Natural Resources Canada
- Dr. Katrina J. Edwards, University of Southern California, USA

EXTERNAL EVENTS

This section documents examples of notable external events that happened during the lifetime of BIO that either directly or indirectly influenced its activities and programs. These include new legislation, creation of new agencies, international agreements, industrial developments and environmental emergencies.

1962

The Diefenbaker Government created the Canadian Coast Guard, under the Department of Transport, to consolidate Canada's fleet of icebreakers, navigation aid vessels and northern supply craft under one agency. The icebreaker CCGS *Labrador* was transferred from the Royal Canadian Navy.

The Atlantic Provinces Inter-University Committee on the Sciences was created and BIO became a long-time member. In 1978, this organization was renamed the Atlantic Provinces Council on the Sciences.

1964

Dr. F. Ronald Hayes left the Institute of Oceanography at Dalhousie University to replace Dr. Jack Kask as the Chairman of the Fisheries Research Board of Canada in Ottawa. He was temporarily replaced by Dr. Ewart Blanchard.

The US Coast Guard began measuring oceanographic conditions at weather station BRAVO in the Labrador Sea (which continued until 1973).

1965

Across the harbour, Dr. Gordon A. Riley arrived from the Bingham Oceanographic Laboratory of Yale University to become the new Director of the Institute of Oceanography at Dalhousie University.

1966

The Science Council of Canada was established.

The first hydrocarbon exploration well was drilled on the Grand Banks.

The Governments of Canada, New Brunswick and Nova Scotia created the Atlantic Tidal Power Programming Board to assess the potential of several dozen sites in the Bay of Fundy for tidal power development.

1967

Mobil Oil drilled the first hydrocarbon exploration well on the Scotian Shelf.

1969

Shell Canada made the first offshore natural gas discovery at the Onondaga well south of Sable Island.

The tanker *Manhattan* made her historic voyage through the Northwest Passage that stimulated new hydrographic surveys.

A spill of elemental phosphorus in Long Harbour, Placentia Bay, NL, stimulated studies to determine its effects on marine organisms.

1970

The A. Murray MacKay Bridge, which crossed the entrance to BIO, was completed and opened to traffic.

The Liberian tanker *Arrow* ran around on Cerberus Rock in Chedabucto Bay, NS, and spilled approximately 2.5 million gallons of Bunker C oil. This was the first major oil spill to be studied in Canada. Soon after, the oil barge *Irving Whale* sank north of Prince Edward Island. BIO staff assisted in clean-up activities and conducted research on effects and recovery.

The grounding of the *Arrow* precipitated the adoption of the Charts and Nautical Publications Regulations under the Canada Shipping Acting that required all vessels in Canadian waters to carry and use up-to-date charts and nautical publications.

The Huntsman Marine Laboratory was established in St. Andrews, NB.

Causeways were built across the Avon River in Windsor, NS, and the Petitcodiac River in Moncton, NB. The impacts of resulting sedimentation were subsequently investigated.

1971

First hydrocarbon exploratory well was drilled on the Labrador Shelf.

1972

The United Nations Conference on the Human Environment, held in Stockholm, Sweden, recognized the need to consider the environmental consequences of human activities.

The Institute of Oceanography at Dalhousie University became the Department of Oceanography.

The Governments of Canada, Nova Scotia and New Brunswick created the Bay of Fundy Tidal Power Review Board to further pursue studies of the feasibility of tidal power.

1973

The Cohasset oil and gas field was discovered on Sable Island Bank that later formed part of the Cohasset-Panuke Project.

A report on the state of research and development in Canada, prepared by a Senate Special Committee on Science Policy chaired by Senator Maurice Lamontagne, was published.

1974

Natural gas was discovered in sediments on the Labrador Shelf.

The *Golden Robin* oil spill occurred in the Bay of Chaleur, QC.

The federal cabinet created the Environmental Assessment and Review Process that required the federal department or agency responsible for initiating a project to assess the environmental impacts.

1975

The Canadian Ocean Dumping Control Act was passed.

1976

The *Argo Merchant* ran aground southeast of Nantucket Island, broke in two and spilled 7.7 million gallons of home heating fuel. BIO staff provided advice in case oil came into Canadian waters.

1977

Canada's Extended Economic Zone, which included fisheries jurisdiction, was extended to 200 nautical miles. This action precipitated changes in the management of northwest Atlantic fisheries.

1978

The Institute of Ocean Sciences opened in Sidney, BC, and the Northwest Atlantic Fisheries Centre opened in St. John's, NL.

1979

Oil was discovered at Hibernia on the Grand Banks.

The Venture gas field was discovered near Sable Island on the Scotian Shelf.

The Northwest Atlantic Fisheries Organization (NAFO) was established to replace the International Commission for Northwest Atlantic Fisheries (ICNAF). Its mandate was to promote optimum utilization, rational management and conservation of fisheries resources.

The *Kurdistan*, a British oil tanker bound for Sept Isles, Quebec, broke up and spilled 7000 tons of Bunker C oil into ice-infested waters off Cape Breton. BIO staff conducted studies on the fate and effects.

1980

The National Energy Program was established. It included incentives for the Canadianization of offshore exploration and enhanced the pace of offshore oil and gas exploration.

1981

The Province of Nova Scotia created the Nova Scotia Tidal Power Corporation to further pursue the development of tidal power.

1982

The Department of Fisheries and Oceans Gulf Fisheries Centre was opened in Moncton, NB.

Canada and Nova Scotia reached a landmark agreement resulting in the first legislation for offshore oil and gas resource management and revenue sharing.

The Ocean Ranger drilling rig sank on the Grand Banks during a severe winter storm and all hands were lost.

The Point Lepreau nuclear power station began operation.

The United Nations Convention on the Law of the Sea (UNCLOS) was established.

1984

The Annapolis Royal Tidal Power Project was commissioned.

The Canada/US Gulf of Maine boundary dispute was settled by the International Court of Justice in Den Hague, The Netherlands. Canada was awarded the productive northeast peak of Georges Bank.

Oil was discovered at Terra Nova and White Rose near Hibernia on the Grand Banks.

A gas blowout occurred at West Venture on Sable Island Bank and took eight months to cap.

1985

Revisions were made to the Canadian Fisheries Act to introduce specific fish habitat protection measures.

1986

The Policy for Management of Fish Habitat was developed and adopted by the Department of Fisheries and Oceans.

The Panuke oil and gas field was discovered that later formed part of the Cohasset-Panuke Project.

The National Energy Program was terminated.

The Canada-Newfoundland and Labrador Offshore Petroleum Board was established.

1987

A large area of the Scotian Shelf (~13,000 km^2) was closed to commercial fishing using otter trawls by the Department of Fisheries and Oceans in order to protect juvenile haddock and their habitat. A few years later, fixed-gear fisheries were also excluded from this Haddock Closed Area.

The Venture Gas Project was shelved due to low energy prices.

The amnesic shellfish-poisoning incident occurred in eastern Prince Edward Island.

The Institut Maurice-Lamontagne, a new federal oceanographic laboratory in Mont Joli, QC, was created that led to a reduction of BIO research in the Gulf of St. Lawrence.

1988

A 12-year moratorium on hydrocarbon drilling on the Canadian sector of Georges Bank was put in place.

1990

The Canada-Nova Scotia Offshore Petroleum Board was established to manage the development of offshore petroleum resources.

1992

Canada was the first industrialized country to ratify the United Nations Convention on Biological Diversity, committing the country to greater conservation, monitoring and education on biodiversity and the sustainability of natural resources.

Oil production started at the Cohasset-Panuke field on Sable Island Bank, heralding Canada's first offshore production.

Due to overfishing, the northern cod population collapsed and a groundfish fishing moratorium was introduced by the Department of Fisheries and Oceans.

The Canadian Environmental Assessment Act was passed by the Government of Canada. It required federal departments, including Environment Canada, agencies, and Crown corporations to conduct environmental assessments for proposed projects where the federal government was the proponent or where the project involves federal funding, permits, or licensing.

1993

The Fisheries Resource Conservation Council was created to form a partnership between scientific and academic expertise and all sectors of the fishing industry with the purpose of making recommendations to the Minister of Fisheries and Oceans on conservation measures for the Atlantic fishery.

1995

The gravity-based structure oil production platform was installed at Hibernia on the Grand Banks.

1996

The Canada Oceans Act received Royal Assent. It outlined Canada's responsibilities in its ocean territories and introduced a new ocean management model based on collaboration among stakeholders and on the principles of sustainable development, integrated management and the precautionary approach. This Act made Canada the first nation in the world to have comprehensive oceans management legislation.

1997

Oil production started at Hibernia on the Grand Banks.

1998

Regulatory approval was granted for the Maritimes and Northeast Pipeline and Sable Offshore Energy Project.

This year was named the official International Year of the Oceans.

Swissair Flight 111 crashed off Peggy's Cove, NS, and BIO ships assisted in recovery operations.

1999

First gas from the Sable Offshore Energy Project was delivered to the Maritimes and Northeast Pipeline.

2000

The drilling ban on the Canadian sector of Georges Bank was extended to 2012.

The Russian nuclear-powered submarine *Kursk* sank in the Barents Sea.

2001

PanCanadian (later Encana) announced plans to proceed with the Deep Panuke Project.

2002

The Species at Risk Act received Royal Assent. This Act became an important tool for the conservation and protection of Canada's biodiversity.

Canada's Oceans Strategy, the federal government's policy statement for ocean management, was released. Based on the authority and direction set out in the Oceans Act, the it defined the vision, principles, and policy objectives for the future management of Canada's estuarine, coastal, and marine ecosystems. This strategy called for ocean governance that emphasized collaboration with all levels of government, shared responsibilities for common objectives and engaging Canadians in oceans-related decisions.

Oil production started at Terra Nova on the Grand Banks.

2003

Encana called a time-out on the Deep Panuke Project to re-evaluate the project's scope and economics.

The United Nations Convention on the Law of the Sea was ratified by Canada.

2005

Premier John Hamm concluded the Atlantic Accord with the federal government yielding Nova Scotia extra revenues from offshore activity.

The Electric Power Research Institute concluded that the Minas Passage was the most suitable site to install and test a Tidal In-Steam Energy Converter.

Oil production started at White Rose on the Grand Banks.

2007

The Canada-Nova Scotia Offshore Petroleum Board approved Encana's Deep Panuke Project.

2009

The Fundy Ocean Research Centre for Energy was created to facilitate the testing of Tidal In-Steam Energy Converters in the Minas Passage. The first test turbine was deployed at the end of year and failed after just a few weeks in the water.

2010

The Deepwater Horizon oil spill occurred in the Gulf of Mexico and BIO scientists were asked to assist with clean-up activities.

The Georges Bank drilling moratorium was extended to 2015.

2012

The original version of the Canada Environmental Assessment Act was repealed by the Harper government and replaced with a weaker and more restrictive version.

SUMMARY

This section summarizes the highlights of the detailed material presented in the preceding sections, following the same format of headings. An attempt was made to illustrate major changes with time over the evolution of BIO. Some additional information is also provided, especially in the summary of program activities.

ORGANIZATION AND STAFF

The establishment of the Bedford Institute of Oceanography (BIO) in 1962 was a unique experiment in the organization of federal science by bringing different agencies together under one roof to share common facilities and develop multidisciplinary programs addressing important marine science issues in Canada. The initial agencies were the Canadian Hydrographic Service (CHS), the Atlantic Oceanographic Group (AOG) of the Fisheries Research Board of Canada (FRBC) and the newly created Marine Sciences Branch (MSB) that became the lead agency. Soon after, components of the Geological Survey of Canada (GSC) arrived. These agencies were under the federal Department of Mines and Technical Surveys (DMTS) and Department of Fisheries and Forestry (DFF). In 1966, DMTS became the Department of Energy, Mines and Resources (DEMR). During these early years there was steady growth in staff, programs, resources and facilities. Internal reorganization led to the creation of the Atlantic Oceanographic Laboratory (AOL) and the Marine Ecology Laboratory (MEL). In 1970, the Resource Management and Conservation Branch (RMCB) was established as well as a small pollution group under the Resource Development Branch.

Major changes in organization occurred in 1971 with the creation of the new federal Department of Environment (DOE). Most components of BIO, including the research vessels, were transferred into this new department with the exception of the geological programs that remained in DEMR and became the Atlantic Geoscience Centre (AGC). In addition, the new Environmental Protection Service (EPS) established a laboratory at BIO. At the national level, a start was made in 1973 to disband the FRBC and all fisheries research was integrated with fisheries operations under the new Fisheries and Marine Service in DOE, along with AOL and MEL.

During this early period, each laboratory had its own administrative and financial support as well as full authority over its programs and resources. However, Institute-wide matters were handled by a committee of directors.

Further major changes occurred in 1976 when DOE became the Department of Fisheries and Environment (DFE). At the national level, all science programs were placed into either the Fisheries Resource Branch (FRB) or Ocean and Aquatic Sciences (OAS). Within BIO, both AOL and MEL became part of OAS under a regional director general. At the same time, institute-wide technical support functions, previously managed by AOL, became a separate management unit. The Atlantic Geoscience Centre (AGC) remained in DEMR. The BIO management committee now expanded to include the new regional director general and the manager of Institute Facilities. This same year saw the establishment of the new Marine Fish

Division, under the Fisheries Resource Branch, and the arrival of the Seabird Research Unit of the Canadian Wildlife Service.

The next major change in organization, again driven by Ottawa, occurred in 1979 when DFE was split into the Department of Fisheries and Oceans (DFO) and Department of Environment (DOE). In this reorganization, the science vessels were transferred to DFO. The Fisheries Research Board of Canada was officially terminated. Both the Fisheries Resource Branch and Ocean and Aquatic Sciences move to DFO while other BIO components were assigned to DOE. Soon after, OAS was renamed Ocean Science and Surveys (OSS). In 1981, the Canada Oil and Gas Lands Administration (COGLA) under DEMR established a regional office that incorporated the previous Resource Management and Conservation Branch. In 1982, DFO created a separate Gulf Region that took over some functions handled by BIO staff. The BIO management committee became known as the Tuesday Club.

Up until this time, these frequent organizational changes driven by Ottawa had minimal effect on BIO projects. The science carried on despite changes in reporting relationships. By the mid-1980s, BIO had built an extensive program that covered the full spectrum of marine science disciplines ranging from physics to fish. The numerous projects, many of which were multidisciplinary in nature, were addressing important marine questions of importance to Canada. Resources were healthy and administrative overhead was minimal. Scientific productivity and morale were high and BIO had earned an excellent international reputation. It was generally considered to be one of the top oceanographic institutions in the world.

This situation started to change in 1986 with a major reorganization in DFO driven by Ottawa. Many influential high-level voices felt that the science program was more interested in basic research than applied and not delivering the kind of information needed by fisheries managers. Their view prevailed and steps were taken to bring science and fisheries management together under the same management structure. Ocean Science and Surveys was disbanded and the regional director general position erased. Oceanography and hydrographic programs were integrated with fisheries programs under a new regional science director who in turn reported to a regional director general responsible for all DFO programs. More emphasis was placed on 'fish' and less on 'oceans'. This marked the end of direct reporting for oceanography programs to Ottawa. The following year, AOL became the Physical and Chemical Sciences Branch (PCSB) while MEL was disbanded. Some MEL staff were laid off or transferred to other regions but most were reassigned, according to discipline, to the either the Physical and Chemical Sciences Branch (PCSB) or the newly created Biological Sciences Branch (BSB). This new organization also included scientific staff at the St. Andrews Biological Station, the Halifax Fisheries Research Laboratory and the Hollis Building in Halifax. At same time, the concept of sector management was introduced which led to the transfer of administrative and financial control from the laboratories to new separate management branches. This move further reduced the authority of science directors and increased administrative overhead. All these changes were very disruptive and had a severe negative impact on morale and productivity. While still under DFO, the Canadian Hydrographic Service continued to function as a line organization and was largely immune to these organizational changes but suffered significant budget reductions.

The regional office of the Canada Oil and Gas Lands Administration (COGLA) departed BIO in 1991. In 1992, Public Works and Government Services Canada arrived on the scene and took over the responsibility of operating BIO facilities from DFO. The following year saw the establishment of the Route Survey Office of the Department of National Defence that was co-located with CHS in the Polaris Building.

Further significant changes in organization started to occur again in 1995 as a result of a major national program review. Within DFO, the Scotia-Fundy and Gulf Regions were combined to form a new Maritimes Region. The Physical and Chemical Sciences Branch and the Biological Sciences Branch were dissolved and merged under the regional science director. While CHS continued to have a separate budget and function as a national organization, the director reported to the regional science director. The Halifax Fisheries Research Laboratory was closed and staff transferred to either St. Andrews or BIO. All science staff at BIO, the Hollis Building in Halifax, St. Andrews Biological Station and the Gulf Fisheries Centre in Moncton were integrated into a new divisional structure under the regional science director based at BIO. While all this was going on, there were substantial reductions in staff and resources. Many personnel took advantage of early retirement packages. Also in 1995, the Canadian Coast Guard transferred from Transport Canada to become a special agency in part of DFO and took over the operation of the BIO fleet of research vessels. And finally, the Department of Energy, Mines and Resources (DEMR) became Natural Resources Canada.

In 1997, there was a marked reduction in the presence of Environment Canada at BIO. The Canadian Wildlife Service (CWS) moved to Queen Square in downtown Dartmouth while most of the Environmental Protection Service (EPS) moved to new facilities in Moncton. However, the next few years saw the arrival of numerous new DFO units on the BIO campus that further expanded the scope of programs, most of which dealt primarily with technical, coordination or management aspects. In 1997, the Oceans Act Coordination Office was created, as well as the office of the Regional Advisory Process. In 1999, the existing Diadromous Fish and Habitat Management Divisions moved into BIO from Halifax, and the new Species at Risk Office was created. The following year saw the arrival of the Aquaculture Coordination Office from Halifax and the Canadian Coast Guard Technical Services Unit from the Parker Street Base in Dartmouth.

In 1999, DFO re-established the Gulf Region that led to further organizational adjustments between BIO and the Gulf Fisheries Centre. The declining numbers of staff led to the consolidation of DFO science personnel at BIO into a fewer number of divisions. In 2006, the regional office of the DFO Regional Advisory Process morphed into the Centre for Science Advice. At the same time, all of the DFO environmental management programs were combined to form the Oceans and Habitat Branch that was later renamed the Oceans, Habitat and Species at Risk Branch and finally the Ecosystem Management Branch. In 2004, the United Nations Convention on the Law of the Sea Office was established under the joint management of the Canadian Hydrographic Service and Natural Resources Canada (Atlantic).

In 2010, the Tuesday Club was renamed the BIO Campus Management Committee and the expanded membership included all principal agencies on site. A Science Management

Committee was also formed the same year to focus on the coordination of BIO science programs with membership from DFO, NRCan, DOE and DND.

As is clear from the above, there have been many changes in the organization of BIO over its history, most of which have been driven from Ottawa. New departments at the national level and new units at the local level were created while older ones disappeared. These changes were driven by numerous factors including politics, new legislation and changing resource levels. Many of these changes had a negative impact on the quality of the science conducted but the highly professional staff always adjusted to the new conditions and endeavoured to deliver the best science possible.

It is not possible to document human resources year by year because of the inconsistency of the figures reported in the Annual and Biennial Reviews. However, a few general observations are noted. At the end of the first year, scientific and technical staff at BIO totalled just over 100. With the growth in scientific programs, this number steadily increased over the first decade and totalled approximately 400 in the early 1970s. These numbers did not include ships personnel and other agencies occupying space at BIO. The number of scientific and technical staff in later years varied somewhat, depending on funding levels and organizational changes. These changes were most pronounced during the program review exercise in the mid-1990s when many staff were laid off or took early retirement. During this period, the recruitment of new scientific staff did not keep up with the losses. However, during this same period, many existing DFO staff moved into BIO when office and laboratory facilities in Halifax were closed. In addition, new staff were recruited to carry out the developing environmental management programs in support of the new Oceans and Species at Risk Acts. During the 2000s, staff numbers remained relatively steady. In 2009, the most recent year for which figures are available, the breakdown of BIO staff was:

DFO Science	365
DFO Oceans, Habitat and Species at Risk	75
DFO Informatics	47
DFO Other	7
DFO Coast Guard Tech Services	44
NRCan GSC Atlantic	101
EC Operational Laboratories	4
DND Route Survey Office	13
PWGSC Site Operations	13
Research Coordination Units	9
Total	678

When BIO opened, there was a shortage of qualified Canadian scientists and many of the initial positions were filled with staff recruited from overseas, in particular the UK and US. This situation changed with time as training in marine sciences increased in Canadian universities and a greater number of well-trained graduates were available. Many of the new recruits were graduates of Dalhousie University, University of British Columbia, McGill, Guelph, Acadia and Memorial.

Throughout the years, BIO has maintained close relations with the academic community and many staff held joint university appointments, especially with Dalhousie University. Numerous graduate students have been housed at BIO while conducting their thesis research. In the early years when funding was available, BIO hired a large number of summer students. Unfortunately, this practise was largely discontinued in recent years due to budget cuts. BIO staff have also been temporarily augmented by numerous visiting scientists, postdoctoral fellows and contractors who made significant contributions to programs.

BIO has always been recognized as a wonderful place to work and over the years there has been no problem recruiting well-qualified staff when positions were available. However, the hiring process is much more cumbersome now than it was in the early years when directors were free to hire whomever they wanted. Many staff became 'lifers' and spent their entire careers at BIO. Few left BIO for positions elsewhere. BIO developed a most collegial atmosphere that was unique for a federal government organization. One outcome of this was the creation of the BIO-Oceans Association in 1998. After retirement, many staff have remained active in BIO programs as emeritus scientists.

It is not possible to document financial resources year by year because of the inconsistency of the figures reported in the Annual and Biennial Reviews. However, a few general observations are noted. During the early growth years, BIO was well funded. The major source was A-Base funds that were allocated directly to laboratory directors for use at their discretion. While some applied work was conducted, the majority of the research projects were more of a fundamental nature addressing current scientific questions of interest to the international scientific community. Funding generally increased year by year to cover inflation and the cost of new programs. Staff did not have to write formal research proposals and competition for funding was minimal. While general direction was provided by headquarters, most funding decisions were made within the Institute. It was easy to develop new research programs and create multidisciplinary teams, often across different agencies. Sharing of resources was common. There was considerable stability in funding from year to year that was a benefit to long term planning.

This ideal situation started to change in the 1980s when A-Base funding began to decrease and B-Base and C-Base funding programs began to appear. These funds came to BIO from other branches of DFO and DEMR or other government departments. They were allocated after an internal competitive process to fund programs addressing government priorities. Scientists had to prepare proposals and funding decisions were made at the national level. Lab directors lost control over allocating funding directly but were involved in preparing and defending regional packages of proposals. This new approach created more review and competition but also increased the administrative workload. Some example of these special funds used by BIO programs include the Panel on Energy Research and Development (PERD), Green Plan, Ocean Dumping, Long Range Transport of Atmospheric Pollutants (LRTAP), Marine Phycotoxins, Atlantic Fisheries Adjustment Program (AFAP), Northern Cod Science Program, Northern Contaminants, Toxic Substances Research Initiative, Environmental Sciences Strategic Research Fund (ESSRF) and the Internal Governance Fund. These B-Base and C-Base programs were an essential source of funds for BIO research programs that supported the overhead of the research divisions and helped maintain research quality. However, these funds were sun-setted and focused on short-term applied research. Despite these various government sources, scientists were still forced to be proactive and seek external funding.

Scientists who had adjunct appointments with Canadian universities could apply to the Natural Science and Engineering Research Council (NESRC) and other university funding bodies for support. These research grants were generally restricted to funding students and postdoctoral fellows who were assigned to university programs but located at BIO. They did not contribute overhead to BIO programs. Collaborative programs were often created with industry, especially the oil and gas and fisheries industries. These were often partly funded through Joint Project Agreements (JPAs). JPAs were also developed with colleagues in other institutes to provide ship time or equipment and receive funding for technicians and postdoctoral fellows in return. External funding was also obtained from international agencies for collaborative studies with other countries. These various external funding sources allowed BIO scientists to continue high quality science in areas that were no longer departmental priorities.

These changes in funding sources further weakened the influence of directors on their laboratory programs. With time, it was not unusual to begin the year with a negative operating budget because the dwindling A-Base resources were used primarily for salaries of full time staff and research was almost entirely dependent on these other resources. The program review exercises of the 1980s and 1990s substantially reduced departmental budgets, set new priorities and led to the demise of long-term expensive programs such as offshore and arctic surveys.

In summary, in the early years of BIO it was relatively easy for staff to establish new research programs. However, due to reduced funding, increased administrative overhead and increased control, it became much more difficult for staff to continue essential programs and create new ones.

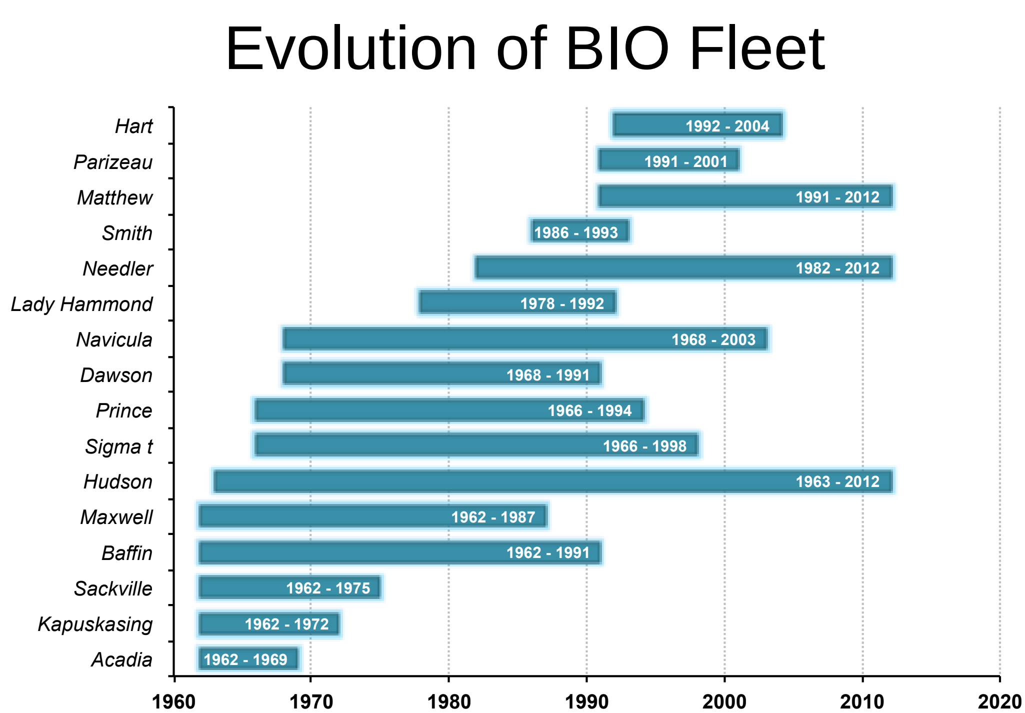
FACILITIES

There was steady growth in BIO facilities as programs expanded and staff increased. During the first decade, both the administrative (now Polaris) and laboratory (now Van Steenburgh) wings of the original main building as well as the Depot (now Vulcan) were expanded. In addition, the Argo Building, the Fish Laboratory and a temporary trailer complex were constructed. Despite these additions, overcrowding conditions continued and a major expansion was undertaken in the late 1970s. This resulted in the construction of the Strickland, Murray and Holland Buildings that were formally opened in 1980. The Holland Building, designed for BIO common services, included a new main entrance, auditorium, cafeteria, library and computer centre. With this new space, the temporary trailer complex was removed. The Coast Guard arrived on campus in 1985 with the construction of the Marine Communications and Traffic Services Building. In 1992, Public Works and Government Services took over the operation of BIO facilities and initiated a long-term program of further infrastructure upgrades and new buildings to meet the demands of the evolving programs. The new buildings included the Ellis Building, completed in 2007, and the Coast Guard Maritimes Headquarters Building that was completed in 2012.

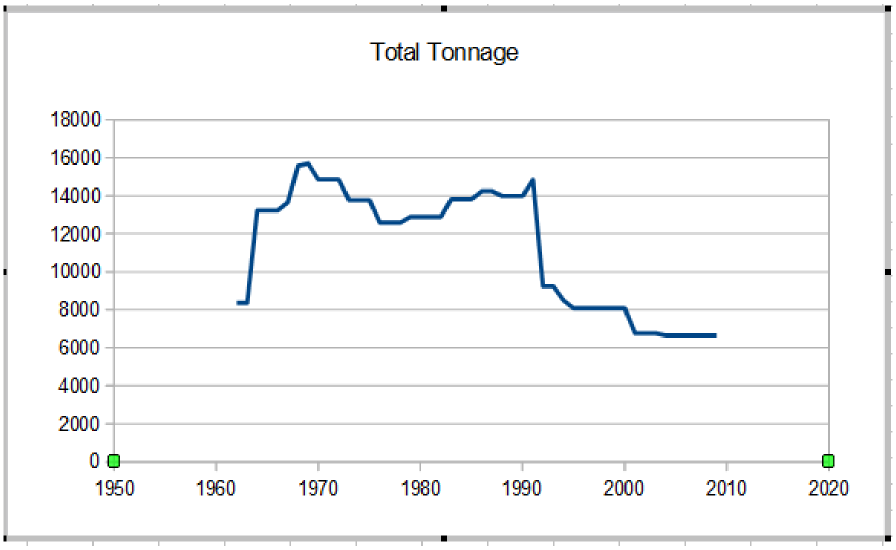
SHIPS

The evolution of the BIO fleet of research vessels is summarized in the figure below. When BIO opened, five major vessels were available. The CHS *Acadia*, CHS *Kapuskasing*, CHS *Baffin* and CHS *Maxwell* were used for hydrographic surveys while the CNAV *Sackville*, operated by the Royal Canadian Navy, was used for oceanographic research. The fleet expanded rapidly in the 1960s. The CCS *Hudson* arrived in 1963 and soon became the queen of the fleet and the envy of other oceanographic laboratories around the world. In 1966, the MV *E.E. Prince* and MV *Sigma-t* joined the fleet, followed the next year by the arrival of the CSS *Dawson* and MV *Navicula*. During the early 1970s, the CCS *Kapuskasing* and CNAV *Sackville* were retired from service but the MV *Lady Hammond* arrived in 1978. The next new arrival was the MV *Alfred Needler* in 1982 followed by the CSS *F.G.C. Smith* in 1986 and the CSS *Matthew* in 1991. This same year saw the retirement of CSS *Baffin* and CSS *Dawson*, but the latter was replaced by the CSS *Parizeau*. In 1992 the CSS *J.L. Hart* joined the BIO fleet that had now reached a maximum of ten vessels. A major change in the fleet occurred in 1995 when the Canadian Coast Guard took over its operation.

The 1990s and early 2000s witnessed a gradual decline in the fleet that reduced quite significantly the opportunities for at-sea research. Some of this shortfall was made up where possible by using other means of gathering data such as remote sensing and instrumented moorings that were able to transmit data ashore in real time. By 2005, only the CCGS *Hudson*, CCGS *Matthew* and CCGS *Alfred Needler* remained in operation, one each for oceanographic, hydrographic and fisheries programs. Two of these vessels were reaching the end of their expected lifetimes and the planning for replacements was initiated.



The evolution of the total tonnage of the BIO research fleet is shown below.



Over the years, BIO also maintained a fleet of hydrographic launches and small boats for inshore use. Programs also used ships of other government departments, in particular the Canadian Coast Guard, charter vessels and research vessels belonging to other countries. Ship time was also made available to university oceanographic research programs. BIO vessels have always interrupted research programs to respond to search and rescue calls as needed. They have also participated in responding to numerous environmental emergencies.

PROGRAM

This section provides an overview of some of the many discoveries made by BIO scientists over the years, organized by disciplines. Some of these discoveries have been geographic in nature and represent important geological, physics and biological features of the ocean that have been mapped by field surveys using a variety of instruments. Other discoveries have been more cerebral in nature and include the development of new concepts, advancing understanding of oceanographic processes and constructing numerical models.

<u>Hydrography</u>

The Canadian Hydrographic Service (CHS) was already well established with a long history in Atlantic Canada when it moved into BIO in 1962, bringing expertise in offshore positioning as well as its fleet of four hydrographic survey vessels. Its core program of conducting hydrographic, current and tidal surveys in Atlantic Canada, Hudson Bay and the eastern Arctic continued, often using charter vessels to supplement its own fleet. CHS also continued to maintain a wide network of tide gauges. The Regional Hydrographer reported directly to the Dominion Hydrographer, priorities were set by Ottawa and during the field season regional staff were supplemented by staff from headquarters. Most of the ship's crews were experienced seasonal employees who returned year after year. CHS was in an expansion mode in the early years of BIO and the role of the Regional Hydrographer in setting priorities and managing budgets increased as more responsibility for program control was transferred from Ottawa.

With time, responsibility for the current program moved to the offshore circulation program, hydrographic ships were used for multi-disciplinary surveys and responsibility for the survey vessels moved to Marine Science Branch support.

The decentralization movement of the 1970's saw a cartographic unit in place by 1978 with an objective of once again having hydrographers and cartographers in the same office. As with many examples of change, there was no immediate increase in productivity as the mix of staff willing to move meant new staff had to be recruited and trained. The first charts produced at BIO appeared in 1980. Thereafter, new charts appeared regularly, slowed by the continuing need to update old charts as new information was obtained and responding to national and international policy and standards changes (metrification, navigational aids, bilingualism) that affected existing charts.

Program review in the 1980's and 1990's to reduce expenditure saw offshore and arctic programs ended, the retirement of larger survey vessels, significant budget reductions and the focus moving to inshore surveys.

At BIO, CHS was a leader in improving accuracy of positioning at sea and integrating different systems to reduce the uncertainty of a ship or station's position offshore. Rapid advances in technology in the early 1990's led to a huge increase in the accuracy and amount of bathymetric data collected. The advent of the global positioning system (GPS) reduced the error in navigation to just a few meters, however, for many years the US Department of Defense degraded the accuracy to hundreds of metres. CHS was instrumental in developing differential GPS and getting the Canadian Coast Guard to broadcast these corrections over Coast Guard radio. The arrival of multibeam echo sounder systems allowed the entire seabed beneath and adjacent to a vessel to be imaged at a resolution of just a few meters. Again CHS was instrumental in working with industry and academia to develop new procedures to determine accurate depth and position information for seabed imagery and to process and store the vast amount of data that could now be collected.

Working with international organizations and industry, BIO hydrographers played a major role in the development of electronic chart prototypes to demonstrate the potential and through time the adoption of international standards. The first appeared in 1987 and by 2009 the International Maritime Organization (IMO) adopted requirements that, between 2012 and 2018, all vessels on international voyages be equipped with Electronic Chart and Information Display Systems (ECDIS). Chart carriage requirements are national, and vary from requirements to carry paper charts, to paper charts assisted by Electronic Chart Systems (ECS), to ECDIS that are recognized as equivalent to paper charts. CHS now supports three product lines; paper charts, a raster image of the paper chart for ECS and Electronic Navigational Charts (ENC) to international standards for ECDIS.

Working in collaboration with BIO geologists and industry, hydrographers have carried out extensive site-specific projects in seabed mapping at various locations using multibeam echo sounder systems. Most recently, this included a high priority program to collect bathymetric and seismic data off Atlantic Canada and in the Canadian Arctic in the foot of the slope region. These offshore and arctic surveys were conducted using Canadian Coast Guard icebreakers, icebreakers from other countries and by contracted vessels. The data will be used for Canada's submission to establish the outer limit of the continental shelf beyond 200 nautical miles under the United Nations Convention of the Law of the Sea (UNCLOS). In 1984, BIO staff from all disciplines prepared technical documentation that was used in the successful resolution of the Gulf of Maine boundary dispute with the US before the International Court of Justice in Den Hague.

By 2012, there was only one dedicated hydrographic survey vessel left in the BIO fleet and it was restricted to coastal areas. Surveys were focused primarily on mapping navigational corridors used by shipping to modern standards.

More details on the hydrography program can be found in MacDougall (2014), Eaton (2014), Grant et al. (2014), Grant and Wells (2014), Sinclair and O'Boyle (2014) and Verhoef et al. (2014).

Geophysics

From the very beginning, BIO built a strong program in geophysics. Many cruises were conducted over the years to collect seismic, gravity and magnetic data on the bedrock underlying the marine waters off Atlantic Canada and the eastern Arctic. Geophysical surveys were frequently carried out in collaboration with hydrographers to make the most efficient use of ship time. These surveys included the continental shelf, Bay of Fundy, Gulf of St. Lawrence, the Labrador Sea and Baffin Bay. In the mid-1960s, geophysical surveys were also carried out on the Mid-Atlantic Ridge that contributed to understanding the emerging exciting concepts of seafloor spreading and plate tectonics. Additional information on offshore bedrock came from cores collected by the oil and gas industry when drilling exploration and production wells. Regulations required that these cores be archived at BIO and available for research on their composition and fossils. A comprehensive data base called BASIN was developed to curate all the data generated from the analysis of these industry cores. These various sources of information led to the important discovery of the series of sedimentary basins underlying the continental margin off eastern Canada ranging from Nova Scotia to Baffin Island. Assessments were subsequently made of the oil and gas potential of these offshore basins and the results were used by industry in planning their offshore developments. Hydrocarbon production from the Scotian Basin off Nova Scotia began in 1992 and the Jeanne d'Arc Basin beneath the Grand Banks in 1997.

For many years, BIO geophysicists participated in various legs around the world of the international deep drilling program using a specialized drilling ship that made additional discoveries that contributed to understanding plate tectonics. In more recent years, the geophysical programs have paid increasing attention to the arctic. Both ice camps and icebreakers have been used to gain more information about the structure of bedrock underlying the Arctic Ocean. Most recently, geophysical surveys off Atlantic Canada and in the Canadian Arctic have been conducted in collaboration with hydrographers and the results will be used for determining the limit of Canadian jurisdiction beyond 200 nautical miles under the United Nations Convention of the Law of the Sea (UNCLOS).

More details on certain aspects of the geophysical program can be found in Mudie and Jackson (2014), Williams et al. (2014), McLean et al. (2014) and Verhoef et al. (2014).

Marine Geology

Over the history of BIO, marine geologists have carried out a wide variety of programs studying the properties and distribution of seafloor sediments in Atlantic Canada, Hudson Bay and the Canadian Arctic. Environments studied included estuaries, coastal inlets, bays, straits, fjords and the continental shelf. At the outset, acoustic information was collected using single beam echo sounders while samples were obtained by grabs and cores. With time, new and improved tools became available including the Huntec high resolution seismic reflection system, sidescan sonar, multibeam echo sounders, better grabs and corers, high quality photographic and video imagery and moored instrumentation to discover new seabed features, such as pockmarks and ice scours, and monitor seabed processes.

A long-term geochemistry program was developed that carried out studies of key estuaries including the LaHave, Miramichi, Halifax Harbour and the Strait of Canso. In the early 1980s, geochemical observations were made as part of an international program examining the feasibility of disposing radioactive wastes in abyssal plain sediments.
A long-term micropaleontology program was also established that included studies of modern foraminifera in coastal and continental shelf environments as well as various palynomorphs (e.g. cysts, pollen, spores), foraminifera and ostracods in rock core samples. Both these programs made valuable discoveries on current and past environmental conditions that could used to understand changes in climate conditions.

A program of particularly high priority over the years has been mapping marine sediments. This work started on the Scotian Shelf using data collected by single beam echosounders and grab samples, with the first map published in 1970. This was followed soon after with maps of other continental shelf areas. With the advent of sidescan sonar and multibeam echosounders, more detailed maps were produced of regions of particular interest such as Halifax Harbour, the Bay of Fundy, Browns Bank and The Gully. Many of these seabed mapping studies were conducted in collaboration with hydrographers, as well as with the oil and gas industry and fishing industry. These maps not only provided insight into important geological processes but they also provided information that could be applied to numerous environmental and fisheries management issues. They also assisted in the assessment of potential offshore aggregate and placer gold resources as well as understanding prominent sediment structures such as pockmarks and iceberg scours. In 2000, geologists, hydrographers, ecologists and defence personal collaborated in developing an ambitious interdepartmental proposal for a national seabed resource-mapping program called SeaMap to map the entire seafloor within Canada’s Exclusive Economic Zone off all three coasts. Unfortunately~~,~~ this program was never funded but for several years Natural Resource Canada funded a Geoscience for Ocean Mapping (GOM) project that applied the SeaMap principles in specific areas on the Scotian Shelf.

Considerable effort over the years has also been given to understanding sediment dynamics. These studies began in the Bay of Fundy in the mid-1970s and included investigating sediment transport processes of both intertidal and subtidal sediments in order to better understand the potential impacts of tidal barrage construction. Studies of sediment dynamics later moved offshore and focused on Sable Island Bank. Both these studies developed numerical models that could be used to predict the effects of environmental changes on sediment erosion, transport and deposition. This new understanding of sediment dynamics contributed to the assessment of sediment stability that was one of several important factors used in defining seabed hazards for offshore oil and gas structures. One particular study investigated the impacts of the 1929 Grand Banks earthquake on the stability of continental slope sediments.

Another high priority program has been the investigation of shoreline processes. Detailed studies have been conducted at various sites in Nova Scotia, Prince Edward Island and along the coast of the Beaufort Sea. These studies have included repetitive observations to see how sensitive shorelines are responding to sea level and climate changes. Many shorelines were found to be retreating at a rapid rate. Beginning in 1979, a long-term program was initiated to map the entire coastline of Canada by aerial reconnaissance and this information was used to construct maps of coastal sensitivity that could be used for planning purposes.

Geologists at BIO have also worked in freshwater environments. In 1991, a multi-year geological program was initiated in Lake Simcoe, the Great Lakes and Lake Winnipeg using the standard marine geoscience methods. Projects were also carried out to investigate the potential impacts of hydroelectric developments proposed by Hydro-Quebec. Extensive studies were also conducted on deglaciation and postglacial sea-level changes in Atlantic Canada.

More details on some aspects of the geological program can be found in Pickrill and Piper (2006), Mudie et al. (2014), Rochon et al. (2014), Pickrill et al. (2014), Fader et al. (2014), Taylor et al. (2014), Piper (2014), Lewis et al. (2014), Todd and Shaw (2014), Schafer (2014), Buckley (2014), Shaw (2014) and Lewis et al. (2014).

Physical Oceanography

The Atlantic Oceanographic Group, created in 1944, already had a well-established physical oceanographic program when it moved into BIO in 1962 that expanded considerably with the creation of the Marine Science Branch. Most of the early projects dealt with ocean circulation, but the program expanded rapidly to cover other aspects of ocean physics during the growth years of the 1960s and 1970s. Field studies of ocean circulation covered a wide geographic area that included the Gulf Stream, the region between Nova Scotia and the Azores, the Grand Banks, the arctic and the Gulf of St. Lawrence. Current meters were an essential source of data and over the years, working with BIO engineers, steady improvements were made in mooring technology that earned BIO an international reputation. During the Hudson 70 expedition, the first deployment of current meters was made in the Drake Passage between South America and Antarctica, an important but poorly understood component of global ocean circulation. Later, more inshore projects were undertaken including investigating the impacts of hydropower development on freshwater discharge into the Gulf of St. Lawrence and determining the circulation in the Bras d'Or Lakes. In 1980, a long-term program was initiated in the Arctic

Ocean to improve understanding of its circulation and global importance. In collaboration with other countries, data were collected from both ice islands and icebreakers. In 1998, a program began to deploy current meter moorings in the Barrow Strait to measure transport of deep water between the Arctic Ocean and North Atlantic. More recently, physical oceanographers have participated in the International Argo Program, the largest ocean climate monitoring system in the world, and are responsible for maintaining free-drifting floats that collect temperature and salinity profiles in the North Atlantic.

Much effort over the years has been devoted to studying the formation of deep-water in the North Atlantic that plays a critical role in global ocean circulation. This research was possible because of the superb ability of the CSS *Hudson* to work effectively under the harsh winter conditions experienced in northern waters. Various field programs, many with international partners, were carried out in Baffin Bay, Davis Strait, the Labrador Sea, the Irminger Sea, Denmark Strait and the Norwegian-Greenland Sea. The Labrador Sea became a region of particular interest and direct observations were made of deep-water formation. This research resulted in numerous important discoveries and was a major contribution to the World Ocean Circulation Experiment (WOCE) established to study the role of the world ocean in the Earth's climate system.

From the very beginning, programs have been carried out on air-sea interactions. These began with studies of energy exchange but expanded to include investigations of wave climate along the Atlantic coast. Information on extreme wave height was needed to improve the design of offshore structures needed by the developing oil and gas industry. Wave specialists also participated in wave studies with European partners in the North Sea. In 1986, physical oceanographers were involved with other agencies in the Canadian Atlantic Storms Program (CASP) project that studied the formation of intense storms. A few years later they participated in a second CASP project and collected various kinds of physical data from the Labrador Current and the Hibernia area on the Grand Banks. Another long-term project investigated the dynamics of internal waves that are formed by offshore tides interacting with the edge of the continental shelf.

A number of programs have studied ocean mixing and turbulence at a number of specific locations. These included the shelf break dynamics program conducted off Halifax starting in 1976, the Cape Sable experiment off southwest Nova Scotia starting in 1987 and the Georges Bank frontal study starting in 1988. Extensive studies on the variability of sea-ice began in the early 1970s with focus on the arctic and coast of Labrador. Extensive field programs have been conducting using a wide variety of instrumentation to measure sea-ice properties and movement.

Over the years, physical oceanographers have produced a large number of numerical models to help understand physical processes and predict future states in ocean properties. One of the earliest examples was the development of tidal models for the Bay of Fundy that could be used to predict the impacts of constructing tidal barrages. This work lead to the discovery that the Bay of Fundy, Gulf of Maine and George’s Bank have to be treated and analyzed as a single oceanographic system. In collaboration with US scientists, detailed simulation models of regional circulation have been developed for large areas of the continental shelf. These models have been continually improved to increase accuracy and resolution. In addition, operational ice forecast models have been developed for the coast of Labrador and the Grand Banks.

Recognizing the value of collecting time-series data to measure changes in ocean conditions, a number of long-term monitoring programs have been established and maintained. The first was the Halifax Section that was started in 1950 before BIO opened. The Labrador Sea Monitoring Program was initiated in 1990. It was followed by the creation of the regional Atlantic Zone Monitoring Program (AZMP) in 1998. A few years later, the Halifax Section was extended seaward to become the Scotia Slope/Rise Monitoring Program. These monitoring programs are now incorporated under the AZMP and include chemical and biological as well as physical variables. The data collected play a critical role of understanding the impacts of climate change on the ocean off eastern Canada.

Other physical oceanographic projects conducted include collecting data from coastal inlets to determine their suitability for aquaculture and compiling ocean data inventory systems so that valuable data collected at considerable public expense are available to all potential users.

More details on the physical oceanographic program can be found in Clarke (2006), Jones (2014), Peterson et al. (2014), Prisenberg et al. (2014), Clarke (2014) and Smith et al. (2014).

Marine Chemistry

There was a small chemical program in the Atlantic Oceanographic Group when it moved into BIO in 1962. Some work was underway on the chemistry of seawater but the major effort was a geochemical study of sediments in the Gulf of St. Lawrence. A technical services laboratory was established to measure basic chemical variables such as salinity, oxygen, nutrients, pH and alkalinity, brought back from the field in sample bottles, for other Institute programs. With time, the workload of this laboratory was reduced with the advent of automation, the development of *in situ* sensors and the development of instrumentation that could be taken to sea. The chemical oceanographic program expanded rapidly during the growth years of the 1960s and 1970s, especially after the creation of the Chemical Oceanography Division in 1970. Studies were conducted in a large number of regions in Atlantic Canada and the eastern Arctic but the Gulf of St. Lawrence remained an area of particular interest. In later years, chemistry programs were conducted in close cooperation with scientific colleagues at the St. Andrews Biological Station and the Halifax Fisheries Research Laboratory.

Various kinds of chemicals and processes were investigated. Numerous studies were carried out on radionuclides in seawater and sediments originating from fallout from atmospheric nuclear weapon testing or accidents, with focus on arctic waters. In 1978, a program was initiated to monitor low-level radioactive wastes released from the Point Lepreau nuclear generation station on the New Brunswick shore of the Bay of Fundy. Other studies examined the distribution of major and trace elements in both seawater and sediments. Considerable effort was invested in measuring the concentrations and distribution of non-living organic carbon and nitrogen in a wide variety of environments, including the deep sea. Stable isotopes of carbon, oxygen and hydrogen were used as tracers to address various questions including feeding relationships in food webs. In addition, measurements were also made of the flux of carbon dioxide between the atmosphere and the ocean.

In order to understand long-term chemical trends in seawater, numerous chemical variables were included in the Atlantic Zone Monitoring Program (AZMP) that got underway in 1998. Beginning in 1997, BIO chemical oceanographers played a leading role in the creation of BIOCHEM that is a national archive of marine biological and chemical data.

With changing DFO priorities and program cuts, the chemical oceanography program began a steady decline in the mid-1990s and disappeared from the organizational structure in 2007.

More details on some aspects of the chemical oceanographic program can be found in Smith (2014) and Yeats (2014).

Ecology

The Atlantic Oceanographic Group had several projects dealing with plankton and benthic communities when it arrived at BIO in 1962 but this ecological program expanded rapidly during the growth years of the 1960s and 1970s. Organizational changes in 1987 imposed from above caused some setbacks and adjustments but the program largely recovered soon after. However, due to declining resources, it began a gradual decline in the 1990s. From the very beginning, the major focus of the ecology program has been understanding the structure and dynamics of marine ecosystems that support fisheries. This has been done using a combination of field, laboratory and theoretical studies.

Plankton studies have addressed both phytoplankton and zooplankton. Over the years, plankton ecology became one of the specialities of BIO and staff earned an international reputation for excellence. As the program developed, considerable attention was given to develop new sampling tools, working in collaboration with BIO engineers.

Considerable attention has been given to measuring the primary production of phytoplankton in a wide variety of marine environments and understanding the many factors controlling it, including light and nutrients. Using new towed instruments such as Batfish, fitted with *in situ* sensors for variables such as temperature and chlorophyll, studies were carried out to investigate the spatial distribution of phytoplankton and the controlling physical processes. It was discovered that picoplankton play a very important role in the transformation of carbon and energy in the global ocean. Methods were developed for estimating the concentrations of chlorophyll in surface waters using satellite imagery and using this new information to estimate primary production by phytoplankton in the global ocean. These exciting discoveries in turn were used to develop a global classification system of biological seascapes. Other parts of the program investigated various aspects of microbial ecology as well as those phytoplankton species that can produce phycotoxins.

Numerous studies also were conducted on feeding and secondary production processes of zooplankton in a wide variety of marine environments, including coastal inlets such as Bedford Basin, the continental shelf and the arctic. In cooperation with BIO engineers, new sampling tools were developed to determine the spatial distribution of zooplankton and these included the towed multiple net system called BIONESS and a towed particle counter with electronic sensors.

Plankton ecologists made important contributions to numerous international multidisciplinary programs such as Global Ocean Ecosystem Dynamics (GLOBEC) and the Joint Global Ocean Flux Study (JGOFS). They have also been involved in several monitoring programs that are collecting valuable data on how plankton communities are adapting to changing environmental conditions brought about as a result of climate change. These included the Bedford Basin monitoring program, which dates back to the 1960s, and the Atlantic Zone Monitoring Program (AZMP), which was initiated in 1998. Studies of under-ice plankton were also conducted in Lancaster Sound in the eastern Arctic during the 1980s.

Benthic studies were also underway when the Atlantic Oceanographic Group arrived at BIO and focused on the benthic communities in the Gulf of St. Lawrence. Like other programs, it expanded during the growth years of the 1960s and 1970s. Shellfish production studies were initiated in the shallow waters of PEI and soon after studies of the growth and mortality of mussels were undertaken in Bedford Basin. These studies contributed the development of the shellfish aquaculture industry. Extensive studies of benthic communities and processes were carried out in St. Margaret's Bay, the Bay of Fundy and St. George's Bay during the 1960s and 1970s as part of larger projects. Several aspects of deep-sea benthic ecosystems were investigated in the early 1980s on the Nares Abyssal Plan as part of the radioactive waste disposal project. Beginning in 1989, various aspects of scallop biology were examined in collaboration with university colleagues as part of the Ocean Production Enhancement Network (OPEN) project.

Exhaustive studies of benthic communities on the continental shelf were carried out as part of the fishing gear impact experiments conducted in the 1990s. These were continued in the early 2000s in a project exploring the relationship between demersal fish and benthic habitat. Due to concerns raised over the impacts of fishing gear, the benthic program expanded further to include studies of deep-water corals which were made possible by the advent of new sampling and imaging tools. Numerous areas were discovered with dense concentrations of deep-water corals. Advances were made in understanding the sensitivity of benthic communities to physical disturbance and defining the concept of critical habitat for important species. Increasing concern over biodiversity led to additional benthic studies on seamounts to assess their ecological vulnerability to damage by fishing gear. Over the years, special attention was given to studying benthic-pelagic exchanges in a wide variety of environments.

While most attention in the benthic program was given to studying invertebrate communities, considerable effort was also devoted to measuring the primary production of benthic plants including seaweeds, saltmarshes and intertidal algae in coastal environments. It was discovered that in some situation their productivity could exceed that of phytoplankton.

Research on fish started soon after BIO was established and grew steadily with time. From the beginning, the focus was on understanding fish as part of the marine ecosystem and not on fisheries per se. Early work included studying various aspects of fish physiology, behaviour, feeding and energetics. Surveys of mackerel eggs and larvae in the Gulf of St. Lawrence in the early 1970s led to the establishment of the St. George's Bay program. The creation of the Marine Fish Division in 1976 brought about further expansion of fisheries research and the work of this new group was focused on fish populations and providing advice for fisheries managers. Beginning in the 1980s, extensive studies were carried out on the recruitment of lobster populations in the Gulf of Maine while, beginning in 1989, various aspects of cod biology were examined in collaboration with university colleagues as part of the Ocean Production Enhancement Network (OPEN) project. Over several decades, considerable effort was devoted to developing acoustic methods for assessing fish populations. Numerous modelling projects were undertaking to understand and describe the dynamics of fish production ecosystems. Ground breaking research was also conducted on investigating the effect of environmental factors on fish populations.

Marine mammal research began in the late 1960s with studies of bioacoustics and the bioenergetics of large whales to learn more about their role in marine ecosystems. In the 1970s, emphasis began to shift to studying the population ecology and dynamics of seals and their impact on fish stocks of commercial interest. Fieldwork focused on Sable Island, an important breeding area. Collaborative work with Dalhousie University led to the development of a seal contraceptive vaccine and a new method for estimating diets based on fatty acids. Also investigated were the role of seals in the life cycle of the cod worm and the impact of feeding on cod. More recent work on whales has been carried under the Species at Risk program.

A formal seabird program for the conservation and protection of populations of seabirds in eastern Canada was formally established at BIO by the Canadian Wildlife Service in 1971. Seabirds are important predators at the top of the marine food web. Research included studying both breeding colonies on land and the distribution of seabirds at sea. Long-term monitoring of populations coupled with oceanographic studies provided insight into understanding the factors responsible for observed changes in abundance. Unfortunately, this program was discontinued in 1997 when the Canadian Wildlife Service moved to Queen Square.

BIO has a long history of conducting multiyear field programs that brought together the disciplines of geology, physics, chemistry and biology to work together cooperatively in studying the production dynamics of marine ecosystems. The first was the St. Margaret's Bay program that was launched in 1966 to explore the dynamics of a coastal ecosystem. This followed shortly after by comparative studies in Bedford Basin/Halifax Harbour and Petpeswick Inlet. In 1973, the St. Georges's Bay program got underway and continued for many years. The Cumberland Basin ecosystem program got underway in 1978 to gather information that could be used to assess the potential impacts of tidal power development. In 1983, the three-year Fisheries Ecology Program was initiated on Browns Bank to understand the relationships between fish and the ecosystem supporting them. Multidisciplinary studies were also carried out in the arctic using ice islands. These included the Canadian Expedition to Study the Alpha Ridge (CESAR) in 1983 and the Canadian Ice Island Program that ran from 1984 to 1989. In 2000, a two-year research program was initiated in the Gully to increase knowledge of this unique submarine canyon off eastern Nova Scotia being considered as a Marine Protected Area (MPA). In 1999, the five-year Science for the Integrated Management of the Bras d'Or Lakes (SIMBOL) Project was launched in collaboration with Cape Breton First Nations. And finally, during the early 2000s, a four-year project examined the relationships between physical habitat, benthic communities and demersal fish at three locations on the Scotian Shelf.

Over the years, a wide variety of theoretical studies have been undertaken by ecologists to develop models of the structure and dynamics of marine ecosystems. Many of these attempted to describe energy flow through an ecosystem to improve understanding of the production dynamics of fish populations. These studies were very dependent upon the results of empirical studies conducted in the laboratory and the field. It was discovered that the biomass of all size categories of marine organisms from bacteria to whales was nearly constant and this led to the development of the biomass spectrum theory. This theory was used to estimate potential fish production in the Gulf of Maine and North Sea as well as to estimate the population density of monsters in Loch Ness. This theory was also used to construct a simulation model of the Grand Banks pelagic ecosystem in the mid-1980s. During the same time period, a simulation model of the entire Cumberland Basin estuarine ecosystem was successfully constructed, using carbon as currency, with the assistance of European colleagues. As the model developed, numerous discoveries were made about the ecosystem functioned. Inverse modelling methods were used to explore food web dynamics. A trophic modelling approach called ECOPATH was used to explore structure and function of the Scotian Shelf ecosystem as part of the Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic (CDEENA) project conducted in the early 2000s. In addition, current state of the eastern Scotian Shelf ecosystem was assessed by analyzing over 60 data sets of biotic, abiotic and human variables, most extending back to at least 1970. Significant temporal changes in ecosystem structure were discovered.

Starting in the late 1970s, ecologists were involved in numerous applied field programs and experiments that explored the impacts of human activities on marine ecosystems. Well after its construction, studies were carried on the impacts of the Canso Causeway. The Bay of Fundy program was carried out to obtain information on the potential impacts of building a tidal barrage for electrical power generation. Beginning in the late 1980s, extensive studies were carried out to determine the environmental impacts of aquaculture, in particular salmon and mussels. A decision support system was developed for habitat managers to assist them in assessing the suitability of different sites. Experiments were conducted on the impact of seismic exploration on marine mammals and snow crabs while other experiments examined the effects of offshore drilling wastes on scallops. And finally, field experiments were conducted to measure the impacts of otter trawling in the Minas Basin and on the Grand Banks and Western Bank, the impacts of hydraulic clam dredging on Banquereau and the impacts of scallop rakes in the Bay of Fundy. Due to changing priorities and decline resources, this work gradually declined during the 2000s.

More details on the ecological program can be found in Harrison (2006), Frank et al. (2006), Li (2014), Gordon et al. (2014), Duplisea et al. (2014), Lambert et al. (2014), Bowen (2014), Nettleship (2014), Hargrave et al (2014), Gordon et al. (2014), Stewart (2014) and Gordon et al. (2014).

Fisheries

Research on harvest fisheries at BIO has evolved in response to the requirements of management. As described above, the initial work on fisheries resources at BIO was devoted to food chain and process studies on a wide range of species. This work significantly expanded in scope after 1977 to meet the increase demands of domestic fisheries management as a result of extended jurisdiction. In these early days, fishery monitoring systems were established, data processing and archiving methodologies designed and algorithms developed to assess the status of fish stocks. Considerable effort was devoted to stock assessment trawl surveys for major groundfish species including haddock, cod, halibut and redfish. Additional information on stocks was collected through the newly-established International Observer Program (IOP). As well, extending the work prior to 1997, a wide range of research in support of fisheries management was undertaken. One of the first major undertakings was the four-year Scotian Shelf Ichthyoplankton Program (SSIP). Other research included studies on fish migration, bycatch in trawl sets and reducing uncertainty in fish stock assessments. The collapse of groundfish resources in 1993 led to an expansion of assessment and associated research on newly exploited species, including new monitoring systems and analytical techniques for fisheries with little data. Analysis of historical data led to the discovery of significant changes in groundfish assemblages over time due to environmental factors and fishing pressure. After 2000, in response to Canada's Oceans Act, increased emphasis was given to developing an ecosystem approach to fisheries management. Programs extended the earlier single species activities and also placed renewed emphasis on the study of the ecosystem impacts of fishing.

Fisheries research expanded yet further when the programs providing support for the management of invertebrate fisheries moved from the recently closed Halifax Fisheries Research Laboratory to BIO in 1996. The program addressed lobster, scallops, snow crabs, shrimp and offshore clams and evolved along four themes. Collaboration with industry was pursued to increase the available data and buy-in from industry. Studies of life history, distribution, growth, reproduction, and mortality of key species were carried out to improve the accuracy of advice given to fisheries and ocean managers. New assessment methods and surveys were developed to inform management and industry on the consequences of different fishing and management strategies. And, as in the demersal fisheries, an ecosystem approach was adopted in assessing exploited populations and the fisheries directed at them.

Fisheries research expanded yet further with the arrival of the diadromous fisheries programs from Halifax in 1999. This work focused on the protection and recovery of species threatened by the impacts of acid rain and habitat destruction, with particular focus on Atlantic salmon and the Atlantic whitefish. Live gene bank programs have been carried out at three regional biodiversity facilities.

BIO fisheries biologists played a leading role in the creation of Fishermen and Scientist Research Society in 2000. They were also instrumental in creating several web-based data management systems that included the Virtual Data Centre (VDC) in 1994 and the Ocean Biogeographic Information System (OBIS) in 2004.

The program developed a well-deserved reputation in the international fisheries science community for high quality and innovative research. This legacy is now passed on to the next generation of fishery scientists.

More details on the fisheries program can be found in Halliday and Fanning (2006), O'Boyle et al. (2014) and Tremblay et al. (2014).

Contaminants

Marine pollution was not a major issue when BIO opened in 1962 but this situation changed before the end of the first decade. In 1969, chemists participated in a project to investigate the impacts an accidental discharge of elemental phosphorus in Newfoundland. Realizing the growing importance of this issue, new staff were hired in 1970 to begin research on the effects of various contaminants on marine ecosystems. Studies were initiated to investigate the distribution, pathways and effects of organochlorine pollutants, in particular the DDT group of pesticides and polychlorinated biphenyls (PCBs). Their dynamics were studied in both zooplankton and seals in habitats including Sable Island, the Gulf of St. Lawrence and the arctic.

Considerable attention was also given to investigating the effects and fate of oil spills. This work began with the *Arrow* oil spill in Chedabucto Bay in 1970. Staff participated in the Operation Oil clean-up exercise and later conducted long-term studies on the weathering of stranded oil. Other major oil spills investigated included the 1978 *Amoco Cadiz* spill in France and the 1979 *Kurdistan* spill in the Cabot Strait. Extensive surveys were carried out to measure both natural and petroleum-derived hydrocarbons in both seawater and sediments ranging from the Sargasso Sea to the arctic. The sublethal effects of petroleum hydrocarbons were determined on a variety of marine organisms including plankton, benthic invertebrates and fish. In 1980, staff participated in the Baffin Island Oil Spill (BIOS) Project that investigated the fate and effects of experimental releases of crude oil on arctic shorelines and determined the effectiveness of shoreline cleanup techniques. This was followed by a long-term program that investigated bioremediation techniques to accelerate the natural decomposition of stranded oil that included field experiments in the US, Nova Scotia, the St. Lawrence Estuary, Europe and the Arctic. A special wave tank was constructed to investigate the effectiveness and toxicity of oil dispersants and the results were used to develop guidelines on dispersant use. As a result of all this research, Canada became much better prepared to respond quickly and effectively to oil spills. Canadian expertise was recognized in 2010 when BIO scientists were invited to help combat the *Deepwater Horizon* blowout in the Gulf of Mexico.

With the advent of drilling offshore exploratory and development wells by the oil and gas industry, a long-term program was initiated in the late 1980s to investigate the behaviour, fate and effects of operational drilling wastes (e.g. muds and cuttings). Field studies were carried out to determine the distribution of wastes around active production platforms on Sable Island Bank and at Hibernia on the Grand Banks. Laboratory studies were carried out to determine the effects of wastes on scallops. A numerical model was developed to predict the biological effects of different waste release scenarios.

Additional studies were done with other contaminants including cadmium, arsenic and mercury. Starting in 1991, staff became involved in the Northern Contaminants Program that addressed concerns over the high levels of contaminants in the diets of Aboriginal peoples. A few years later, staff began to participate in Gulfwatch that was a long-term program monitoring numerous contaminants in mussels in the Gulf of Maine.

In 1971, an aquatic toxicity laboratory was established under the newly created Environmental Protection Service to carry out applied research for the environmental protection of fresh and coastal waters. Bioassays were developed and used to determine the toxicity of a wide variety of chemicals including industrial effluents, dispersants, pesticides and contaminated environmental samples. A microbiological program was also created to monitor bacterial contamination in shellfish. With the exception of the microbiological unit, this program was moved to Moncton in 1997.

Due to changing government priorities and resource cuts, the contaminants program gradually eroded during the 2000s and only the Centre for Offshore Oil and Gas Energy Research (COOGER) remained in 2012.

More details on some aspects of the contaminants program can be found in Addison et al. (2014), Wells and Doe (2014) and Gordon et al. (2014).

Environmental Management

Environmental management responsibilities at BIO began in 1970 with the creation of the East Coast Office of the Resource Management and Conservation Branch to oversee the development of the offshore oil and gas industry. This office morphed into the regional office of the Canada Oil and Gas Lands Administration (COGLA) in 1981 and reminded on campus until 1990.

From the 1960s to the late 1980s, fish habitat protection was carried out by a small group of scientists within the Freshwater and Anadromous Branch of DFO based in Halifax. Initially, its operations were confined primarily to lakes, streams and marine shorelines. In 1986, DFO released a national Policy for the Management of Fish Habitat that led to the establishment the following year of a regional Habitat Management Division, initially based in Halifax but which moved to BIO in 1999. Working under the authority of the
Fisheries Act, the expanded habitat program played an important regulatory role in the conservation and protection of fish habitat by addressing the mitigation of impacts from a wide variety of activities including road and bridge construction, commercial and residential developments, causeways and major energy developments. In carrying out this mandate, habitat managers have worked closely with BIO scientists and provincial agencies. One example was a research project to evaluate the effectiveness of concrete reef balls as an option for habitat compensation.

In 1997, the Oceans Act Coordination Office was established at BIO immediately after the new Oceans Act came into force. This Act laid the statutory foundation for modern oceans governance and management in Canada. The oceans program developed rapidly in close collaboration with BIO scientists. New staff were recruited to provide the wide range of knowledge, skills and expertise needed address the interface of marine science, oceans policy, and ocean-use decision making. Particular attention was given to the integrated management of marine and coastal activities and the development of marine protected areas (MPAs) using an ecosystem approach to achieve a reasonable balance between sustainable economic activity and marine ecosystem conservation. Notable accomplishments included the development the Eastern Scotian Shelf Integrated Management (ESSIM) Plan, the first such plan in Canada for integrated sea-use planning and decision-making on the continental shelf, and the establishment of The Gully as a MPA. In addition, conservation areas were established the Northeast Channel and Laurentian Channel for the protection of deep-water corals.

In 1999, the Species at Risk Office was established at BIO in anticipation of new legislation to protect at-risk species and to coordinate regional, national, and international biodiversity obligations. Since the Species at Risk Act (SARA) came into force in 2004, this office has coordinated and managed the activities involved in meeting federal responsibilities under SARA. These activities have included the assessment, listing, protection, recovery, monitoring, and evaluation of at-risk species that have included marine mammals, sea turtles, marine-diadromous-freshwater fish and freshwater mussels. One species of particular interest has been the North Atlantic right whale. Since its inception, the office has worked with partners inside and outside of BIO to promote a better understanding of at-risk species and the conservation requirements and activities necessary for their recovery.

In 2000, the Aquaculture Coordination Office moved to BIO from Halifax and its program continued to focus on implementing improvements to the regulatory framework and the site approval process, updating the framework for operational decision-making and working with the provinces and industry to establish mechanisms for cooperation and harmonization.

All of these programs, which have evolved over a 25-year period in response to changing government policies and new legislation, have contributed significantly to the improved management and sustainable use of marine and freshwater environments in Canada.

More details on the environmental management program can be found in Murphy et al. (2014).

Provision of Advice

As federal civil servants, BIO staff have always been required to provide scientific advice on fisheries and environmental issues. In the early years of BIO, the process was quite informal and advice was usually provided by individual scientists as requested. However, in the late 1970s, more formal mechanisms for providing scientific advice were established. In providing scientific advice, care was taken to present information objectively and not take sides on controversial issues. Decision-making was left up to the responsible managers or elected officials.

When BIO opened, the offshore fisheries were in international waters and regulated by the International Commission for the Northwest Atlantic Fisheries (ICNAF) that moved into BIO in 1963. Discussions at the Third United Nations Conference on the Law of the Sea (UNCLOS) in 1976 reached a stage that countries felt they were in a position to declare 200-mile fishing zones.

Subsequently, in 1977 Canada extended its jurisdiction over most of the fishing banks off the Atlantic coast and thereby assumed responsibility for fisheries management. However, important fishing areas, such as the nose and tail of the Grand Bank and Flemish Cap, lay outside the new limits and thus there was continued need for international fisheries management in these areas. This led to the creation in 1979 of the North Atlantic Fisheries Organization (NAFO) that was based at BIO.

Prior to extending jurisdiction, there were no formal mechanisms in Canada for applying the results of scientific programs to fisheries management on an ongoing basis. However, after extending jurisdiction, Canada could not continue to deal with its greatly expanded responsibilities on the same *ad hoc* basis. This led to the creation in 1977 of the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC), also based at BIO, which coordinated the provision of scientific advice to fisheries managers until its demise in 1992. This advisory role was subsequently taken over by the independent Fisheries Resource Conservation Council until the creation in 1997 of the Regional Advisory Process (RAP) to coordinate the development of peer reviewed science advice for fisheries management. The RAP office was also located at BIO and its role broadened over time to provide advice on all marine conservation issues. In 2006, the RAP office evolved into the Centre for Science Advice (CSA).
With regard to coordinating the provision of advice on environmental issues, the first step was the creation of the Marine Advisory and Industrial Liaison Office (BIOMAIL) in 1980. This was followed by the creation of the Marine Assessment and Liaison Division (MALD) in 1987 to facilitate the collaboration between DFO Science and Habitat Management. The responsibility for coordinating the provision of scientific advice on environmental issues was subsequently transferred to the RAP office when it was established in 1997.

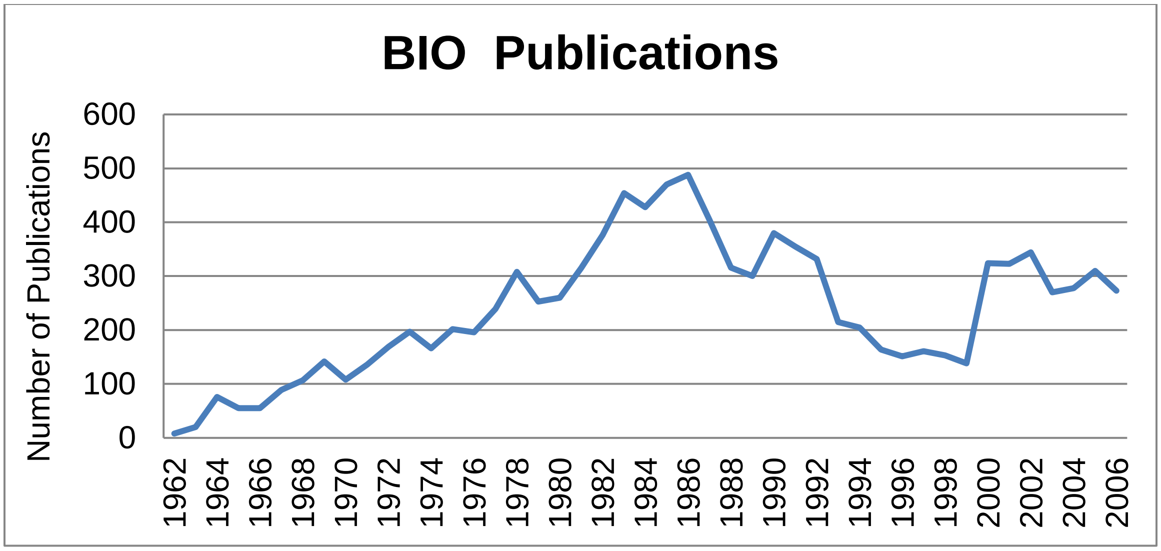
More details on providing scientific advice are presented by Halliday and Fanning (2006), O'Boyle et al. (2014) and Murphy et al. (2014).

Products

Over the years, BIO has produced a large number of tangible products. The most visible have been scientific publications, hydrographic charts and a wide variety of maps. Full details for most years are provided in the Annual and Biennial Reports. The evolution of the publication rate is illustrated in the figure below that shows the total number of publications by year. The data come the BIO Bibliography prepared by Library staff and available on line at:

http://www.nfl.dfo-mpo.gc.ca/libraries-bibliotheques/bibliographies/home.

It contains citations for books, reports, and papers published in scientific journals and conference proceedings written by all BIO staff. Data are not presented after 2006 for the numbers are lower than reported in the annual reviews suggesting that the Bibliography is incomplete in recent years.



As expected, the publication rate increased steadily during the growing years and reached a maximum over 400 a year during the mid-1980s. It then declined steadily for about ten years due to major organizational changes that had a negative effect on scientific productivity. The cause of the increase beginning in 2000 is not clear but could due to several factors including the arrival of scientific staff when facilities in Halifax were closed, the growth of the environmental management program and casting a wider net to capture more of the grey literature.

The production of paper hydrographic charts at BIO began in 1980 and has continued at a steady pace. The production of electronic hydrographic charts began in 2001 and it too has continued at a steady pace.

The production of paper hydrographic charts at BIO began in 1980 and has continued at a steady pace, with the majority of effort on maintenance of the existing chart portfolio. The production of electronic hydrographic charts began in 2001 and it too has continued at a steady pace with the focus on most heavily used routes.

TECHNOLOGY

The concerted effort placed on developing new instrumentation in support of BIO programs over the years has paid handsome dividends. A wide variety of new and novel tools were developed in partnership between scientists and engineers and used to collect unique and valuable oceanographic data. These included buoys, moorings, towed systems, seabed systems and water column profilers. In most cases, scientists identified a need for a particular kind of data and then discussed their requirements with engineers who then proceeded with design, building and testing, a process that often took many years to complete.

Different kinds of buoys were developed to collect physical data from the sea surface and transmit them ashore for processing. Over the years, a concerted effort was made to improve current meter mooring technology. Steady progress in mooring design, increasing the depth and duration of deployments and perfecting recovery techniques led to significant improvements in quantity and quality of current meter data. Another significant undertaking was the DOLPHIN

(Deep Ocean Logging Profiler Hydrographic Instrumentation and Navigation) program in the 1980s that developed a submerged remote-controlled vessel for hydrographic surveys.

A wide variety of towed instruments were developed to collect information from a research vessel while underway. For example, the Huntec Deep Tow Seismic (DTS) system was developed to determine the properties of seabed sediments in support of mapping initiatives. A towed vehicle named Batfish was developed that could carry temperature, salinity and plankton sensors and move up and down the water column in a porpoise-like fashion to collect information on spatial distributions. An instrument with ten opening and closing nets, controlled from the surface, named BIONESS (BIO Net and Environmental Sensing System) was developed for studying the spatial distribution of zooplankton and related oceanographic variables. An acoustic fish counting system called ECOLOG was developed over many years to provide quantitative estimates of fish size and stock abundance independent of sampling by trawl. And finally, the Moving Vessel Profiler (MVP) was developed to deploy various oceanographic sensors from research vessels, merchant vessels and ferries and continuously sample the water column while underway at full speed.

A large number of novel instruments were also developed to collect information on the seabed. During the 1960s, a series of rock core drills was developed for collecting samples of bedrock. The deep-water version was powered by hydrostatic pressure while the shallow version was powered by electricity. Other seabed instruments included ocean bottom seismometers, chambers to measure benthic-pelagic exchanges and moored platforms such as Ralph to measure sediment transport processes. New instruments for collecting benthic organisms and video/photographic imagery of seabed habitat included an epibenthic sled, Videograb, Campod and Towcam.

Another field of technology where BIO has made major advances was in the development of profiling instruments that can move up and down the water column and make repetitive measurements. One of the first was OCTUPROBE (OCeanic TUrbulence PROBE), a vertically profiling free-fall vehicle equipped with sensors for measuring ocean turbulence. Soon after, an improved version called EPSONDE was developed. A platform called SEAHORSE, capable of carrying various sensors, was created that used wave motion to move itself up and down a vertical cable. An instrument called Icycler was developed that could collect repetitive vertical profiles of oceanographic data while moored at a fixed location under ice. This was operated by a unique patented energy conservation technique. Building on the success of Icycler and using the same energy conservation technique, an instrument named Seacycler was developed for deployment in the open ocean to profile the upper 150 m of the water column with a substantial sensor suite and transfer data ashore by means of satellite. In addition, in 2000, BIO assumed responsibility for maintaining a fleet of profiling ALACE drifting floats over the entire western Atlantic Ocean as part of the international ARGO program to measure temperature and salinity profiles from the surface to 2,000 m over a period of 4-5 years and transmit the data ashore via satellite.

New instruments were also created for studies of ice. Ice beacons were developed for deployment on pack ice by helicopters to measure properties and movement, and data were transmitted in real time back to BIO via satellite. In addition, a helicopter-mounted instrument called Ice Pic was built to monitor pack ice properties as a complement to on-ice sampling and deployment of ice beacons.

In addition to developing instrumentation, numerous software tools were developed to improve the collection, processing and archiving of oceanographic data at sea. These included a geophysical data logging system named GEODAL, an improved data logging system named BIODAL, the Hydrographic Automated Acquisition and Processing System (HAAPS), the Graphical Online Manipulation and Display System (GOMADS) and the hydrographic hyperspatial (HH) code. The latter was needed to store the millions of soundings recorded with the advent of multibeam electronic sounders.

During the lifetime of BIO, the accuracy of navigation increased profoundly. In the early 1960s, electronic means of navigation were in the early stages of development and most offshore positions were made using celestial methods. These were weather dependent and accuracy was often no better than a kilometer. By the 1980s, Loran-C became the standard with much improved accuracy. However, by the end of the 1990s, with the advent of the satellite-based global positioning system (GPS), navigation was no longer weather dependent and uncertainty was reduced to just a few meters. As navigation technology evolved, various programs were developed by engineers to provide the best navigation support to BIO field programs. These include the BIO integrated navigation system (BIONAV) and the AGC navigation display and logging system (AGCNAV).

Much of the technology developed at BIO was of wide interest to the international scientific community and many organizations expressed interest in obtaining instruments. However, since BIO is not in the manufacturing business, wherever a potential for commercial development was possible, the technology was transferred to private industry for marketing, production and sales. In addition, a number of patents have been obtained for BIO technology.

Like other aspects of the scientific program, the scope of technical development has declined markedly in recent years due to resource cuts, reduce staff and reduced sea time.

More details on some aspects of the technology program can be found in MacLean et al. (2014), McKeown et al. (2014), Fowler et al. (2014). Grant et al. (2014) and Grant and Wells (2014).

CONFERENCES AND WORKSHOPS

Over the years BIO staff have played a major role in the organization of regional, national and international conferences and workshops. Many of these were held in Halifax and other locations in the province but the majority were held on site, especially after the opening of the auditorium in 1980 that provided a superb venue for large gatherings. Many of the conferences were organized on behalf of professional societies while others were conceived and organized by BIO staff. On occasion, BIO provided the venue for the meeting of different scientific committees.

The many workshops brought together the scientific community, as well as external stakeholders, to discuss in an open forum the results and their application of various research programs. Many of these workshops were concerned with environmental issues such as oil and gas development, construction of coastal engineering works, aquaculture and the impacts of fishing. BIO also put considerable effort into organizing Open Houses approximately every five years to give the general public a glimpse into the scope of BIO programs and their importance to Canada. Through all these activities, BIO maintained important communication with regional, national and international scientific communities as well as with other government agencies, industry, environmental organizations and the public.

HONOURS AND AWARDS

The excellence of BIO staff has been well illustrated by the large number of national and international awards they have received. In addition, they have received ten honorary degrees from universities, eight have been elected to the Royal Society of Canada and two have been made members of the Order of Canada. BIO has also created awards of its own. Beginning in 1980, the A.G. Huntsman Award has been given annually to an international scientist who has made outstanding contributions in marine science. Initiated 2001, the Beluga Award is given annually to a member of the BIO community who has exhibited unselfish dedication to the community spirit of the Institute.

PROMINENT VISITORS

Over the years, a large number of prominent visitors have visited BIO. While most were scientific, the list also included students, various delegations, elected officials and Royalty. For example, Her Majesty Queen Elizabeth and Prince Phillip visited in 2010.

EXTERNAL EVENTS

Over the years, numerous events external to BIO took place that had either a direct or indirect influence on activities and programs. These included new legislation, creation of new agencies, international agreements, environmental emergencies and industrial developments (especially dealing with energy).

CONCLUSION

The Bedford Institute of Oceanography (BIO) was established in 1962 at a time when the federal government recognized that oceanography was a national priority and investment in marine research would pay long-term dividends for Canada. Its creation recognized the importance of locating all marine science disciplines together under one roof where they could freely interact, share common facilities and generate new information on the ocean for the betterment of Canadians. The program began with fundamental research on geological, physical, chemical and biological processes, plus hydrography and engineering support. With time, the scope expanded to include more applied research on the impacts of human activities on the ocean and the resources it produces. BIO, which in the early years operated very much like a 'federal' university, developed into Canada's largest centre for ocean research and earned an international reputation for excellence. In more recent years, increasing emphasis has been given to fisheries and environmental management activities in support of legislative requirements. BIO has clearly fulfilled the vision and expectations of its wise founders.

For fifty years, BIO has conducted multidisciplinary oceanographic research for the public good of all Canadians. Many exciting discoveries about the ocean have been made. Some of these discoveries have been geographic in nature and have identified important features of the ocean while others have been more cerebral in nature such as developing of new concepts, advancing understanding of oceanographic processes and constructing numerical models. This extensive, state-of-the-art research has led to a much better understanding of the physics, chemistry, geology and biology of the ocean as well as the impacts of human activities. This new information has been effectively applied to resolving marine issues of high national priority.

One of the strengths of BIO has been having all the marine science disciplines together under one roof that over the years has encouraged the development of multidisciplinary research teams across the different agencies. As a result, BIO developed an international reputation for excellence in numerous cross-discipline areas. Just a few of the many examples include:

- Development of new technology for collecting and processing information on the physical, geological, chemical and biological properties and processes in the ocean
- Understanding the oceanography and geology of the Gulf of Maine, Gulf of St. Lawrence, Atlantic Canada continental shelf, Labrador Sea and the Arctic Ocean
- Analysis of ecosystem dynamics including all trophic levels
- Development of numerical models that describe important physical, geological, chemical and ecosystem processes in the ocean
- Understanding the impacts of human activities, both contaminants and physical disturbance, on marine ecosystems and their recovery potential
- Development of multidisciplinary monitoring programs to document long-term changes in oceanic properties and processes
- Understanding the role of the ocean in global processes and the impacts of climate change
- Mapping bathymetry along with the properties of seabed sediments, habitats and biological communities

- Understanding the effects of environmental factors on fisheries production and promoting an ecosystem approach to fisheries management.
- Devising new habitat and ocean management practices and tools to help ensure the long-term sustainability of marine habitats and organisms

This chronology of BIO over its first fifty years clearly demonstrates the benefits to Canada of having a well-equipped, multidisciplinary oceanographic institute with experienced scientific, engineering, and technical staff working together to address important marine issues of national importance. While much has been accomplished by BIO since its founding in 1962, our knowledge of the ocean remains incomplete while the pressures induced by human activities steadily increase. In recent years, there has been a significant reduction in research programs but at the same time there has been a significant increase in management activities in support of federal legislation. There is continuing need for more marine research to safeguard the health of Canada's oceans, support sustainable resource management and address future policy needs of the country. Federal government laboratories like BIO are needed to conduct the research necessary for the public good, especially programs directed by legislative mandates, that will not be carried out by universities or industry. Examples include renewable and non-renewable resource assessments, long-term environmental monitoring programs, tracking marine biodiversity and species at risk, understanding the impact of human activities on marine ecosystems, assessing the impact of oceanic forces and geohazards on marine development activities and, perhaps most importantly, understanding the impacts of future changes in ocean climate.

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