A HISTORY OF THE MARINE ECOLOGY LABORATORY, BEDFORD INSTITUTE OF OCEANOGRAPHY (1965-1987)

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Published by the
BIO-Oceans Association
Dartmouth, Nova Scotia

2021

Correct citation for this publication:

Gordon, D.C. 2021. A history of the Marine Ecology Laboratory, Bedford Institute of Oceanography (1965-1987). BIO-Oceans Association Website, 165 p.

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DEDICATION

This history is dedicated to Dr. F. Ronald Hayes who, while Chairman of the Fisheries Research Board of Canada, had the foresight of expanding the Atlantic Oceanographic Group at the Bedford Institute of Oceanography into the Marine Ecology Laboratory. He also had the wisdom to hire Lloyd Dickie as the first director and helped provide him with the necessary resources to develop it into a major world-class scientific institution of great benefit to Canada.

ABSTRACT

The Marine Ecology Laboratory (MEL) was one of the principal scientific laboratories at the Bedford Institute of Oceanography (BIO) in Dartmouth, NS. Created in 1965 as an independent laboratory under the Fisheries Research Board of Canada (FRB), it grew out of the previous Atlantic Oceanographic Group (AOG) with the broad mandate to study the structure and dynamics of marine ecosystems supporting marine fisheries. With time, it developed a well-rounded program of basic and applied ecological research and earned an international reputation for excellence. In 1987, it fell victim to a major reorganization of the Department of Fisheries and Oceans driven by short-sighted Ottawa managers and was closed despite protests from the international oceanographic community. However, once the dust had settled from this unfortunate incident and despite declining resources, ecological research at BIO has continued to flourish under the new organizational structure.

INTRODUCTION

The Marine Ecology Laboratory (MEL) was one of the principal scientific laboratories at the Bedford Institute of Oceanography (BIO) in Dartmouth, NS. Created in 1965 as an independent laboratory under the Fisheries Research Board of Canada (FRB), it grew out of the previous Atlantic Oceanographic Group (AOG) with the broad mandate to study the structure and dynamics of marine ecosystems supporting marine fisheries. I became familiar with MEL while doing my PhD in oceanography across the harbour at Dalhousie University and thought that one day it might be an ideal place to work. However, after finishing my degree, the next step in my career was a faculty position in the Department of Oceanography at the University of Hawaii.

One day in March 1970, I received an unexpected phone call in Honolulu from Lloyd Dickie, the Director of MEL. He informed me that the lab was creating a new division to carry out pollution research and offered me the position as head. I was both stunned and elated. After a brief discussion with my wife Joleen, I immediately called back and accepted the offer without asking any further details. It was one of the happiest days of our lives for it had been our wish to return to Nova Scotia as soon as a suitable job opened up. I felt extremely lucky to have landed this most enviable position for there was nowhere else we would rather be, both personally and scientifically. Our marvellous two-year honeymoon in tropical paradise was over but we had no regrets leaving. We arrived at BIO in early October 1970 and, in the first week back, we bought a house, picked up our first Gates canoe and learned that our first child was on the way. What a way to start a new job!

I was most fortunate to have been able to enjoy an exciting 35-year career as a research scientist and manager at BIO working with wonderful colleagues and to be able to continue my affiliation as an emeritus scientist after retirement.

We all knew at the time that we were working under exceptional circumstances and made the most of them. For many years I had thought about preparing a history of MEL but other priorities got in the way. However, in early 2020, I decided that the time had come and when I announced my intention to colleagues I was pleased to receive an enthusiastic response. Soon after I started, we were hit with the Covid-19 pandemic and the bulk of the work in preparing this history was done during the subsequent lockdown. It was an ideal project to work on at home under these unusual conditions.

This account is a labour of love that I hope accurately chronicles the history of MEL and its many contributions to developing a deeper understanding of global marine ecosystems and applying the results to environmental and fisheries issues in Canada. It begins by reviewing the origin of MEL. It then describes the evolution of its staff and programs over its twenty-two years as an independent federal research laboratory under the leadership of three directors; Lloyd Dickie, Alan Longhurst and Ken Mann. The concurrent changes in science policy, federal science organization, mandates and policies under which the lab had to function are discussed. This was a period in the federal government during which there was a steady trend of increasing central control from senior managers in Ottawa. Considerable attention is given to documenting the events that led to the unfortunate closure of MEL in 1987. It then reviews the continuation of ecological research at BIO after MEL was disbanded. The final section presents a synthesis of major highlights in the history of the lab. Appendices are included which provide detailed information on staff, projects, awards, books written by staff and photos of key staff and facilities.

The information included in this history came from a variety of sources and I have endeavoured to be as objective as possible in my interpretation of facts and events. Major sources were the annual reports of the Atlantic Oceanographic Group) (AOG), the Fisheries Research Board (FRB) and the Bedford Institute of Oceanography (BIO). Thank goodness the respective directors at the time had the foresight to commission these invaluable sources of historical information for posterity. Unfortunately, BIO ceased producing annual reports after 2009 which is a real loss to future historians. Other important sources of information included the history of FRB (Johnstone 1977); *Voyage of Discovery*, the commemorative volume celebrating the 50th anniversary of BIO (Nettleship et al. 2014); the BIO Chronology (Gordon 2018) and the unpublished memoirs of Ken Mann. In addition, I extracted a wealth of information from my own personal files and those loaned to me by Eric Mills. Finally, numerous colleagues provided yet further information while reviewing earlier drafts, in particular Alan Longhurst and Mike Sinclair.

This history is a story that must be told. The immediate target audience is the many past MELers who are still with us today. I hope that this account brings back lots of memories but realize that those of the 1986-1987 period may not

be the most pleasant. It should also be of interest to the broader BIO community, past, present and future. Hopefully it will also be of interest to the broader Canadian marine scientific community and government research managers. There are valuable lessons to be learned from this story that should be considered in the future management of federal science in Canada.

BEGINNINGS

Much of the information in this section has been condensed from the excellent article by Mills (2014) on the development of Canadian marine science before the opening of the Bedford Institute of Oceanography (BIO) in 1962. This should be consulted by anyone wishing greater detail on how events evolved during this formative period.

The origins of the Marine Ecology Laboratory (MEL) can be traced back to 1898 when a Board of Management composed of Canadian university and government scientists was established. This Board was the first research organization financed by the federal government whose direction was primarily the responsibility of academic scientists. One of its first accomplishments was to construct and manage a moveable floating research station on the Atlantic coast. Building on the success of this venture, in 1908 the Board created two biological stations, one in St. Andrews, NB, and one in Nanaimo, BC. Until 1925, these stations had no permanent employees but provided seasonal research facilities for academic scientists and their students. In 1912, the Board of Management became the Biological Board of Canada and its membership expanded to include the fishing industry. In 1937, this Board became the Fisheries Research Board of Canada (FRB).

The FRB was organized as an autonomous scientific institution reporting directly to the Minister of Fisheries and administered by a Board which included representatives from universities, government and industry. FRB proceeded to develop an expanded network of fishery research stations across the country to conduct investigations of practical and economic problems connected with marine and freshwater fisheries, flora and fauna. It was also tasked to perform work that may be assigned by the Minister. In order to report its findings, it developed an extensive and highly respected publication series. With time, FRB earned an international reputation for excellence in aquatic science. The evolution and many accomplishments of FRB are well documented by Johnstone (1977) and Hubbard (2000). In addition, the history of the St. Andrews Biological Station (SABS), one of the original two biological stations, has been recorded by Hubbard et al. (2016) while the history of the Halifax Fisheries Research Laboratory has been well documented by Stewart and Safer (2005).

While the focus of FRB was on fisheries, from the very beginning it recognized the importance of understanding the physical, chemical and biological

properties of the supporting ecosystems. In 1911, Archibald Gowanlock Huntsman began his long association with the St. Andrews Biological Station (SABS). A biologist in training, he realized early on in his lengthy career the importance of understanding environmental processes when studying marine production and fisheries. He was greatly influenced by Johan Hjort, a noted Norwegian fisheries scientist who came to Canada to organize the Canadian Fisheries Expedition (CFE) of 1915. The purpose of the CFE was to explore for new fisheries in the Gulf of St. Lawrence, in particular herring, and it incorporated new physical and chemical methods recently developed in Europe. This venture was most successful and had a major impact on fisheries and marine research in Canada. Unfortunately it was interrupted by World War I but soon after Huntsman was able to organize a series of additional comprehensive fishery surveys including both physical and biological observations at various east coast locations.

In 1919, engineers proposed a tidal power development in Passamaquoddy and Cobscook bays straddling the US-Canadian border. Huntsman was concerned about the possible effects of this project on all aspects of marine commercial species production and a number of physical oceanographic and fisheries investigations were conducted by the nearby SABS. After promoting for many years the need for a full time physical oceanographer at SABS, in 1928 he finally got funding to hire Harry Hachey who previously had been teaching physics at the University of New Brunswick. Upon arrival, Hachey began a series of descriptive physical oceanographic studies along the Atlantic coast ranging from Passamaquoddy Bay to Hudson Bay. Later, his work focused on the physical oceanography of the Bay of Fundy region and the Scotian Shelf until it was interrupted by World War II.

A few years after Hachey was hired at SABS, Jack Tully joined the Pacific Biological Station (PBS) in Nanaimo, BC, to begin physical oceanographic studies on the west coast. With time, he nurtured a working relationship with the Royal Canadian Navy (RCN) and used their vessels for oceanographic work.

Before World War II, oceanography in Canada, including physical oceanography, marine biology and fishery biology, was done entirely at SABS and PBS under the FRB. Soon after the war began, increasing attention was paid to physical oceanographic research because of the threat of German submarines and acoustic mines to North Atlantic shipping. The RCN recognized that they did not have the scientific capability to use the available sonar gear effectively and understand the effects of varying oceanographic conditions on its operation. Accordingly, in 1941 the National Research Council (NRC) became the research arm of the RCN. Jack Tully was prevented from serving overseas in the war by an artificial leg but he continued to conduct physical oceanographic research at PBS in support of anti-submarine warfare in collaboration with US oceanographers. In 1943, he was

seconded from PBS to continue this work under the RCN. During the early part of the war, Harry Hachey served in the Canadian Army in England but, in 1944, he returned to SABS and worked on preparing acoustic transmission charts for submarine detection. During the war, both Tully and Hachey rapidly gained experience in defense-related physical oceanographic research.

In 1944, two new federal agencies were established under the FRB to conduct oceanographic research, one on each coast. The Atlantic Oceanographic Group (AOG) was located at the St. Andrews Biological Station (SABS) in New Brunswick and headed by Harry Hachey. The mandate of AOG was to study the ocean environment and its dynamics taking into account the processes which maintain or modify ocean conditions in both inshore and offshore waters. The initial focus was on physical oceanography but soon expanded to include geology, chemistry and biology with strong links to fisheries. The geographic area of interest was the entire Atlantic Canada continental shelf, and projects were initially carried out in the Grand Banks, Labrador Sea, Gulf of St. Lawrence, Scotian Shelf, Gulf of Maine and Bay of Fundy. Ships were provided by the RCN, in particular the CNAV *Sackville*, a corvette converted as a research vessel after the war. On the west coast, the Pacific Oceanographic Group (POG) was located at the Pacific Biological Station in Nanaimo, BC, and headed by Jack Tully.

After the war, AOG and POG continued to evolve as Canada's major oceanographic research groups. On the east coast, AOG expanded their earlier studies of the Scotian Shelf and Bay of Fundy region and began work in the Gulf of St. Lawrence and northeastern Newfoundland waters in support of the SABS fishery program. Later, AOG began moving offshore and studied the slope water off Nova Scotia. In 1950, they collaborated with the Defence Research Board (DRB) and US oceanographers in Operation Cabot, a multi-ship study of the Gulf Stream. And still later they conducted research in the eastern arctic using the HMCS *Labrador* and CNAV *Sackville*, both based in Halifax.

On the west coast, one of the new programs started by POG under Jack Tully in the mid 1950s was an ecological study of the physical, chemical and biological processes underlying fisheries production. John Strickland was hired to build a team of scientists at the Pacific Biological Station to pursue this theme and one of first scientists he recruited was Tim Parsons in 1958 (Parsons 2006).

In addition to FRB, the National Research Council (NRC), Royal Canadian Navy (RCN), Defence Research Board (DRB) and several Canadian universities were also expanding into ocean science. The need for national program coordination was recognized which led to the creation of the Joint Committee on Oceanography (JCO) in 1946. The JCO was composed of representatives from federal agencies and universities and was charged with

coordinating the development of oceanography in Canada and allocating federal resources. FRB provided administrative support, SABS and PBS while the RCN provided ship support. Harry Hachey, now the Chief Oceanographer of Canada, was appointed as chairman.

The JCO soon decided that oceanographic research in Canada needed to be further expanded, as was being done at the time in both the US and Europe. In 1953, Jack Kask was appointed as the first full-time chairman of FRB with instructions to bring together its largely autonomous branches, including oceanography, and to transform FRB into a world-class fisheries organization. He was not interested in developing the broader field of oceanography any further under his command since he saw the principal responsibility of the FRB being fisheries. He felt that FRB should retain only fisheries-related oceanographic research and that other oceanographic programs should be transferred to another federal agency. All parties soon agreed that an expanded oceanographic effort for Canada fitted better under the newly created oceanographic program in the Department of Mines and Technical Surveys (DMTS).

William van Steenburgh, who had a background in agricultural research and had previously been with the Defence Research Board's armaments research centre at Valcartier, had joined DMTS in 1956 as Director-General of Science Services. Before long he was promoting to the JCO the intention of DMTS going into oceanographic research. He felt that Halifax was the natural site for a major new national oceanographic laboratory. It already was the site of the Defence Research Establishment Atlantic (DREA) of DRB and the regional office of the Canadian Hydrographic Service (CHS). It was also the homeport of the HMCS *Labrador* that was supporting federal arctic oceanographic programs. In addition, the FRB was considering moving AOG from St. Andrews to Halifax, plus discussions were already underway regarding the creation of an Institute of Oceanography at Dalhousie University. By 1959, van Steenburgh had received Treasury Board approval for a new oceanographic research vessel and a new oceanographic laboratory. Soon after, plans were initiated to design the CSS *Hudson* and the Bedford Institute of Oceanography at a site on the shore of Bedford Basin in Dartmouth, NS. These were indeed exciting times for the continuing development of Canadian oceanography.

In 1959, the JCO was reorganized and expanded to include the University of British Columbia (UBC), the University of Toronto and Dalhousie University and renamed the Canadian Committee on Oceanography (CCO). William van Steenburgh was appointed chairman and Harry Hachey served as secretary. Its mandate was to coordinate and direct work in oceanography and to represent the Canadian government internationally in the field of oceanographic research.

The intention to create a new organization for oceanographic research in DMTS was initially strenuously opposed by William Cameron who at the time was Director of Scientific Services for the RCN and who had previously inaugurated the oceanographic teaching program at UBC after earning his PhD at Scripps. He felt this move would further fragment oceanography in Canada, plus DMTS had no tradition of research. However, van Steenburgh eventually won him over and, in 1960, he joined DMTS as Director of Oceanographic Research.

In 1960, AOG moved from St. Andrews to Halifax but still reported to the St. Andrews Biological Station. Now headed by Neil Campbell, another physical oceanographer, AOG initially occupied a group of single story wooden buildings (now gone) on Terminal Road between Hollis and Water Streets across from the Nova Scotian Hotel (now the Westin). Staff included Ron Trites, Art Collin, Bill Bailey, George Taylor and Carl Cunningham.

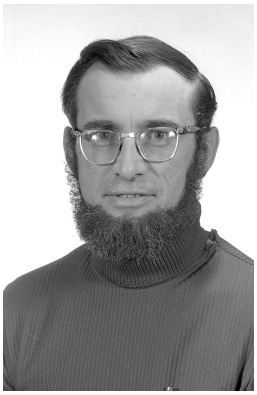

Ron Trites


George Taylor


Carl Cunningham

Soon after this move, Doug Loring and Don Peer joined AOG.


Doug Loring


Don Peer

Two years later, AOG with its staff of about twenty moved across the harbour into BIO when it opened in October, 1962. In an address given the day before

at Dalhousie, van Steenburgh expressed his hopes for the new institute he had taken the lead in creating:

> "We hope that the new Institute will encourage close coordination and provide an integrated oceanographic program. If our plans and hope materialize, this Institute will become an important national and international research establishment."

BIO when it opened in 1962

AOG was one of the two federal agencies initially housed at the new Bedford Institute of Oceanography (BIO) (Gordon et al. 2014a). The other was the newly created Marine Sciences Branch (MSB), under DMTS, that included the Canadian Hydrographic Service (CHS). The first MSB director was Bill English, a physical oceanographer from the west coast. Up until this time, all oceanographic research on the east coast had been conducted by AOG. However, with the creation of MSB, this was about to change. With the new resources at hand, the MSB program rapidly expanded with a focus on hydrography, physical oceanography, chemical oceanography and engineering. MSB was designated as the lead agency at BIO and managed the facilities and support functions (i.e. Library, Photo Unit, machine shops, etc.) as well as the fleet of research vessels at that time (CHS *Acadia*, CHS *Kapuskasing* CHS *Baffin*, CHS *Maxwell* and CNAV *Sackville*).

The AOG program soon expanded in its new home, built specifically for oceanographic research, and began to place increasing emphasis on strengthening the biological aspects of its program while still maintaining expertise in physical and chemical oceanography. New staff included Anand Prakash and Mark Hodgson. Its basic mandate continued to be understanding the fundamental links between the environment and fisheries. Projects were conducted in close collaboration with MSB. Soon after moving into BIO, Ron

Trites took over as Oceanographer-in-Charge of AOG when Neil Campbell moved to a new position with the MSB in Ottawa.

Anand Prakash

Mark Hodgson

In 1963, the Secretariat of the International Commission for North Atlantic Fisheries (ICNAF), created in 1949, moved into BIO. This international body was responsible for the management of offshore fisheries which at that time included most of the Canadian continental shelf. In 1964, Bill English resigned as Director of the MSB Laboratory and was replaced on an acting basis by Earlston Doe, a physical scientist working on air-sea interactions.

Mention should be made of the Royal Commission on Government Organization that was appointed in 1960, chaired by businessman J. Grant Glassco, to inquire into the organization of the Government of Canada. Its five-volume report, released in 1962 and 1963, recommended that government departments should be managed on a decentralized basis, that Treasury Board should be reorganized and that senior managers should rotate between departments. It also recommended that government should let the managers manage, that federal departments should be free of inappropriate central control and that they should be allowed to devise management methods suited to their needs. This was good news for FRB in general and AOG in particular for this is how they had been operating.

After moving to BIO, AOG continued some of its earlier programs and began new ones. These included studies of the deep ocean circulation between Nova Scotia and the Azores, 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. More attention began to be given to groundfish and understanding the processes affecting the movement and distribution of fish eggs and larvae. Studies were conducted on the community structure of benthic organisms in the Gulf of St. Lawrence in order to better understand the distribution and feeding of groundfish. In

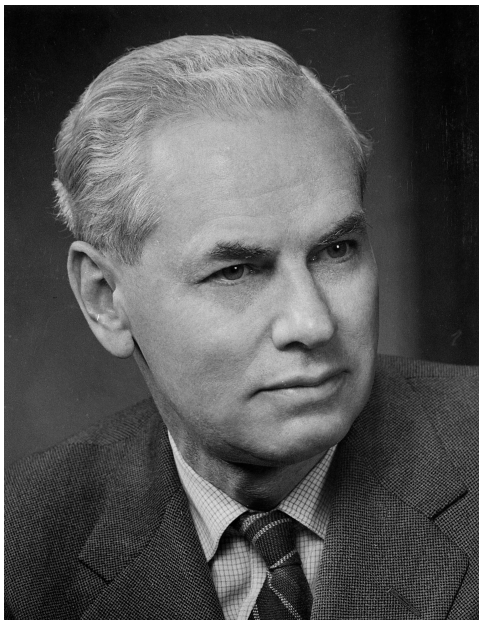
addition, the first multidisciplinary teams were assembled to study complex ecosystems such as bays and estuaries. One investigated the cause of oyster deterioration at Ellerslie, PEI, while another evaluated the environmental processes at Point Belledune, an industrial area in northern New Brunswick.

Soon after the creation of AOG and POG under the FRB in 1944, it was realized by the JCO that there was a need to develop oceanographic programs in Canadian universities to help train the new scientists needed to staff the expanding programs of marine research in federal laboratories (Mills 1994). Trained Canadian marine scientists were in short supply, particularly in the field of physical oceanography, and on-the-job training was not efficient. This led to the creation of the Institute of Oceanography at the University of British Columbia (IOUBC) in Vancouver, BC, in 1949. Ten years later in 1959, a similar Institute of Oceanography was established on the east coast at Dalhousie University (IODal) in Halifax, NS. A close relationship was developed with BIO, including joint appointments. Over the years, both IODAL and IOUBC produced numerous well-trained graduates at the MSc and PhD levels who, as planned, subsequently joined federal marine research laboratories, including MEL (see Appendix 1).

This new institute at Dalhousie was initially directed by F. Ronald Hayes. A native of Parrsboro, NS, he received his graduate education at Dalhousie and the University of Liverpool. He had previously served as the Chairman of the Dalhousie Biology Department. While his scientific specialty was comparative vertebrate anatomy, he possessed a broad ecological perspective and was interested in the dynamics of aquatic systems. For example, he had conducted an innovative ecosystem study of a Nova Scotian lake in which he added radioactive phosphorus to the water and traced its distribution in all components of the biological community, both in the water column and in the sediments. He proceeded to develop the new institute in collaboration with the existing Departments of Biology, Chemistry, Geology and Physics (Waite 1998). It was supported directly by the National Research Council and indirectly by other federal agencies. By 1963, there were nine faculty members with cross-appointments from the other departments and twelve graduate students pursuing MSc degrees. The program was coordinated by the CCO and included collaboration with AOG.

In 1964, Hayes left the Institute of Oceanography at Dalhousie for a new challenge in marine science. With his wife Dixie Pelluet, who also had been a professor in Department of Biology, he moved to Ottawa to become the new Chairman of FRB, replacing Jack Kask. He was the Board's second full-time chairman. Under his tenure there was a sharp increase in university participation in FRB activities. For example, a grants program was established to develop centers of excellence in aquatic science in Canadian universities, universities were encouraged to use FRB facilities and graduate student and postdoctoral fellowships were promoted at FRB stations. He also endeavoured

to increase the number of FRB scientists holding honorary university appointments.



F. Ronald Hayes

Ewert Blanchard, a physical scientist, replaced Hayes as Director of the Institute of Oceanography on an acting basis, and the search for a new director was begun by the university president, Henry Hicks.

By the end of 1964, AOG with its broad oceanographic research program was well established as a major component of BIO under the direction of Ron Trites but still reporting to St. Andrews. However, major changes were just around the corner.

DICKIE YEARS (1965-1974)

1965

This was a pivotal year for the continuing development and expansion of Canadian marine science, both at BIO and Dalhousie University. The Atlantic Oceanographic Group (AOG), now with a staff of about 20, was elevated to the status of an independent FRB laboratory and now reported directly to the FRB Chairman, Ron Hayes in Ottawa, instead of St. Andrews. Lloyd Dickie was appointed as the director of this new independent FRB laboratory.

Hailing from Kingsport, NS, Lloyd was the son of a commercial fisherman. When he told his father about his intention of attending university, his father replied that was probably a good idea for he did not have what it took to be a fisherman! After getting his BSc degree from nearby Acadia University, he went on to earn a MSc degree at Yale University and a PhD in fisheries

biology at the University of Toronto. Following his graduate studies, Lloyd worked as a research scientist at the St. Andrews Biological Station from 1951 to 1961, specializing in scallop research. Carl Medcof, a shellfish biologist, was an important mentor for him. Subsequently, he was given a leave of absence from FRB to return to the University of Toronto to work on fish population dynamics with Juri Paloheimo.

Lloyd Dickie

Upon completion of this leave, he returned to the Maritimes. One day by chance he got into a conversation about gardening with Dixie Pelluet, the wife of Ron Hayes. Lloyd alluded to the fact he had no firm plans for the future. Low and behold, the next day he got a phone call from Ron Hayes in Ottawa asking if he wanted to lead the planned expansion of AOG at BIO. At first, Lloyd wasn't too interested but Ron said to think about it for 24 hours and call him back. By the time Lloyd returned the call the next day, he had decided to accept the director job.

When Lloyd arrived at BIO soon after there was still a lot of empty space. He was encouraged to walk around and pick a spot for his office. He did so and selected an empty office beside that of the MSB director on the harbour side of the main building (now Polaris). He found a chair from somewhere and sat down looking out the window to admire the view over Bedford Basin. At that very moment, the *Bluenose* went sailing by under full sail and, being a Nova Scotian, he realized that he was where he should be.

Soon after, Martin Blaxland was hired as executive assistant and Sylvia Smith as secretary. A start was made recruiting additional administrative staff to support the expanding program and responsibilities. These were the days before personal computers, word processing software, the Internet and email. All documents were typed (with carbon copies) by secretaries and communications were by phone, post or talking over coffee. Hard copies of correspondence were filed in Central Registry and circulated as needed.

Like other FRB laboratories across the country, AOG was responsible for deciding and directing its own research program within its general mandate. Directors had full control over all support functions. A-Base funding, an annual allotment provided by Ottawa with few restrictions, was abundant and distributed to projects at the discretion of Lloyd. These funds were quite stable from year to year, which aided the planning of multiyear research programs, and salaries were secure. External funds were not necessary so no time was needed to write proposals and compete for funds as university colleagues had to do. Being an integral part of BIO, AOG also had full access to the various support services managed by the Marine Sciences Branch (MSB), the lead agency at the Institute. Ron Trites served as assistant director.

This year also saw the arrival of Bill Ford to become the new director of the Marine Sciences Branch (MSB) laboratory and thereby the overall director of BIO. A chemist in training, he had previously worked with DuPont, the Woods Hole Oceanographic Institution (WHOI) and the Canadian Defence Research Board (Gordon 2016). He had earlier been approached by van Steenburgh to become director when BIO opened in 1962 but the timing was not right for him to move at that time. Hence, Bill English was initially appointed to the position.

Soon after arriving, Bill established a committee of directors of the various BIO laboratories to oversee the running of the steadily expanding Institute. From the very beginning, BIO was managed as a single enterprise to protect the interests of each individual component no matter to which federal department or branch they belonged. All directors around the table had equal rights. It was agreed from the start that it was better to cooperate than to quarrel over resources. This committee met on a regular basis and Bill always supplied the coffee and tea, procured by his secretary Joan Sims from the cafeteria. This committee strongly promoted scientific collaboration across the disciplines, sharing of resources and a collegial atmosphere. Even though the participants changed, this tradition continued for many years and the committee eventually became know as the Tuesday Club (because it met every Tuesday).

A third marine scientist of note to arrive in Halifax in 1965 was Gordon Riley to become the new Director of the Institute of Oceanography at Dalhousie University. He was a highly-respected biological oceanographer from the US who had previously worked at WHOI and the Bingham Oceanographic Laboratory at Yale University (Gordon 2019). Gordon and Bill Ford were already good friends having worked together at WHOI during World War II. Both had been involved in conducting oceanographic surveys of Bikini Atoll in the western Pacific in 1946 immediately before the atmospheric atomic bomb tests. Being against nuclear weapons, both had felt very uneasy about being assigned to this project against their wills. In addition, Gordon had previously met Lloyd while he was at Yale pursuing his master's program. He

subsequently assisted Lloyd in recruiting new MEL staff from both the US and Dalhousie.

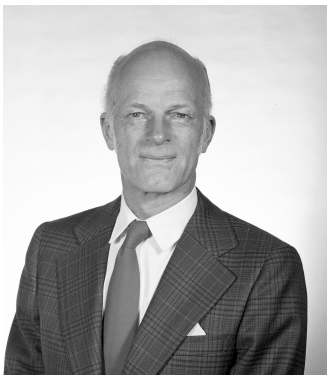
Under the guidance of Ron Hayes and Lloyd Dickie, the AOG program continued to expand with focus on studying the environmental processes underlying marine production with special reference to fisheries. The basic mandate was to describe pathways and measure amounts and rates of energy transfer in marine biological communities and to study the structure and organization of biological systems in the sea. It was felt that physical oceanographic properties have strong effects on ecosystem function and production at all levels of the food web leading to fish. Therefore, there was need to know much more about the functioning of the marine ecosystems of which the fish were part. Fisheries were viewed as just one part of the overall marine ecosystem. Accordingly, they developed a laboratory in which scientists were given a general area to be explored and then encouraged to discover the secrets of how marine ecosystems are structured and function, including the physical factors controlling them.

The prime focus on studying the ecosystems supporting fisheries taken by MEL was a somewhat different approach than that taken by other FRB labs at the time. While some scientists in other FRB labs had conducted their research within an ecological context, in particular at St. Andrews, the overall programs had more of a fisheries management and technology focus. At the time, most commercial stocks were managed on a single species basis with little attention given to considering multispecies interactions and environment factors.

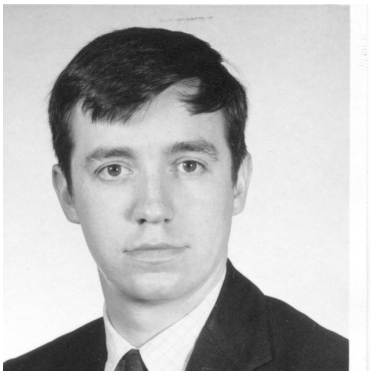
Lloyd was given a free hand in recruiting the new interdisciplinary staff that was needed to carry out the expanding ecological program. While preference was for Canadians, he was also able to recruit new staff from outside the country. His style was to select the most promising candidates available, especially recent graduates eager to unravel the mysteries of marine ecosystems, and then, with minimal direction, provide them with the resources needed to address what they thought were the most important questions in their general area of expertise to tackle. He took great pains to protect them from the necessary administrative requirements and his office door was always open for discussions. Everyone was encouraged to think big. To confer this degree of scientific freedom in a federal government agency required considerable finesse on Lloyd's part but he had the full support of Ron Hayes in Ottawa. This approach created a very stimulating and productive research environment that paid handsome dividends well into the future. It also was in tune with the earlier recommendations of the Glassco Commission.

The first new scientist that Lloyd hired was Trevor Platt. Trevor came from the University of Toronto after completing a masters degree in physics (he later earned his PhD in biology from Dalhousie). Other new AOG staff hired this year included Vivian (Brawn) Srivastava, Juri Paloheimo, John Bentley and

Brian Fraser. Vivian, a fisheries biologist, was the wife of Shiri Srivastava, a geophysicist with MSB. Juri was a population ecologist who had worked earlier with Lloyd at the University of Toronto. While AOG was recruiting ecologists, the MSB Laboratory continued to expand as well with an emphasis on physical oceanography, engineering and hydrography.

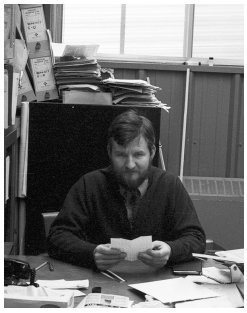


Martin Blaxland



Trevor Platt

Vivian (Brawn) Sirvastava



John Bentley

Brian Fraser

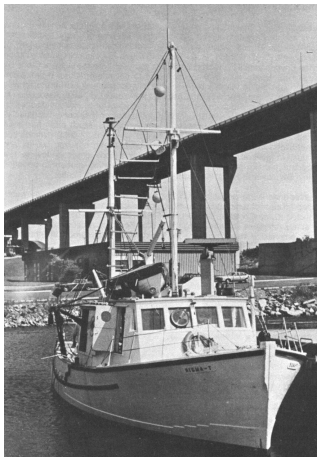
Some program highlights:

- Physical oceanographic studies were conducted in the southern Gulf of St. Lawrence, Margaree Estuary and Pictou Harbour (Trites).
- Studies of the geology and sediment geochemistry were initiated in the Gulf of St. Lawrence (Loring).
- The physiology and ecology of marine dinoflagellates were studied (Prakash).
- Surveys of benthic communities were conducted in the Gulf of St. Lawrence (Peer).
- The relationships among food, body-size and growth efficiency in fish were studied (Paloheimo and Dickie).
- Studies were initiated on fish physiology and behaviour (Srivastava).

1966

The Atlantic Oceanographic Group (AOG) was renamed the Dartmouth Laboratory of the Fisheries Research Board. The *Sigma-t*, a repossessed

fishing boat, was purchased and converted for inshore research work. In addition, the newly built stern trawler *E.E. Prince* was delivered for use in fisheries research. A new section of Applied Oceanography, headed by Ron Trites, was created with staff from both AOG and MSB to pool the resources of BIO staff working on practical problems. This overlapped with the Environmental Oceanography Division of AOG, also headed by Ron Trites.

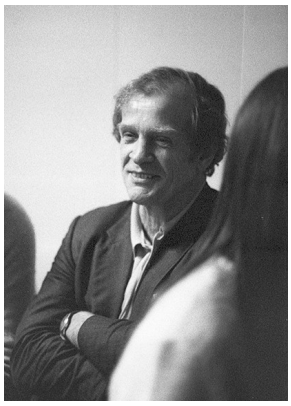


Sigma-t

E.E. Prince

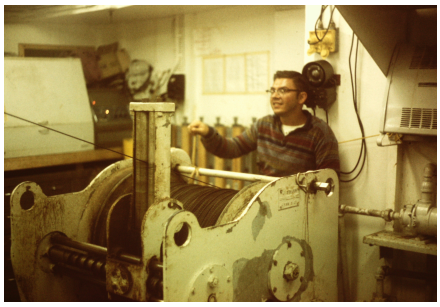
Fisheries Research Board senior staff in 1966.
Seated (l. to r.): C.J. Kerswell, L.M. Dickie, J.L. Hart, W.E. Ricker, K.S. Ketchen, F.R. Hayes, W.R. Martin, G.I Pritchard, J.C. Stevenson, J.S. Wilmer, W.E. Johnson. Standing: J. Rogers, W. Templeman, D.R. Idler, H.L.A. Tarr, N. Tomlinson.

Staff increased from 25 to 37 and the numerous new arrivals included Bob Conover, Brian Irwin, Iver Duedall, John Smith, Steve Paulowich, Dick Dowd and Harry Jarosynski. Bob Conover was a zooplankton ecologist who arrived from the Woods Hole Oceanographic Institution (WHOI) with his red Old Town canoe and fly fishing gear. He had earlier done his PhD at Yale under the supervision of Gordon Riley.



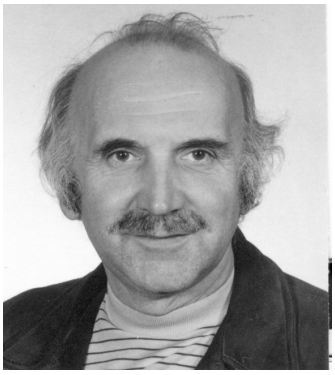
Bob Conover

Brian Irwin



Iver Duedall

John Smith



Steve Paulowich

Dick Dowd

Harry Jarosynski

Some program highlights:

- Physical oceanographic studies were conducted in St. Margaret's Bay and Cabot Strait (Trites).
- A long-term program studying primary production by phytoplankton was initiated (Platt).
- A long-term program studying zooplankton ecology was initiated (Conover).
- Work began on the development of an acoustic echo-counting system for determining the abundance and distribution of fish stocks that could be used to complement data collected by traditional trawl surveys (Dickie, Dowd, Paulowich).
- A multidisciplinary and multiyear ecosystem research program was initiated in St. Margaret's Bay to investigate the production dynamics of a complete coastal system. This was the first study of this nature undertaken in Canada and set a precedent for future ecosystem projects to follow. This bay was considered large and deep enough to serve as a microcosm representative of larger marine ecosystems. Integrated studies of physical oceanography, plankton, benthos and fish were initiated. This multiyear study later became a component of the International Biological Program (IBP), an international program of biological studies focused on the productivity of biological resources and their response to environmental change (Dickie, Trites, Platt, Peer, Bakken, Srivastava).

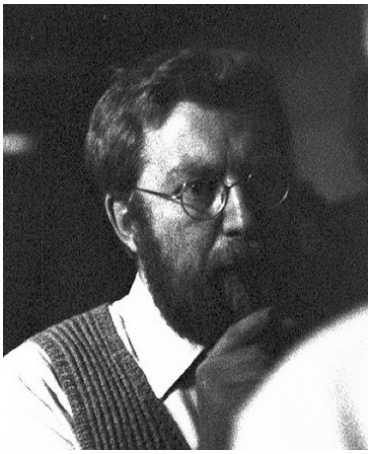
1967

This year saw the arrival of Bill Sutcliffe and Ken Mann. Bill was a biological oceanographer who came from Lehigh University. Before that he had worked at WHOI. He was also the Director of the Bermuda Biological Station, a post he continued for several years after moving to MEL. As with Bob Conover, Gordon Riley played a major role in recruiting him. When Bill came for his interview, he was most impressed with what he saw and proclaimed, "It was as if God said let there be oceanography!" Ken Mann was a freshwater ecologist who came from Reading University in the UK where he had worked extensively on the River Thames ecosystem.

Other arrivals this year included Ray Sheldon, Doug Sameoto, Tim Lambert, Subba Rao Durvasula, Al MacDonald, Ray Rantala and Jim Frost. Ray Sheldon, originally a sedimentologist, came from the FRB Pacific Biological Station in Nanaimo, BC where he had learned how to operate a Coulter Counter while working as a PDF under Tim Parsons. Doug had just completed his PhD at Queens under Eric Mills while Tim had just finished his MSc at Dalhousie.

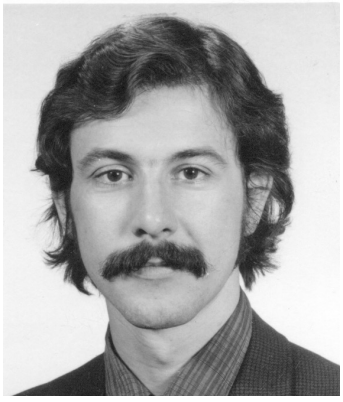
Bill Sutcliffe

Ken Mann



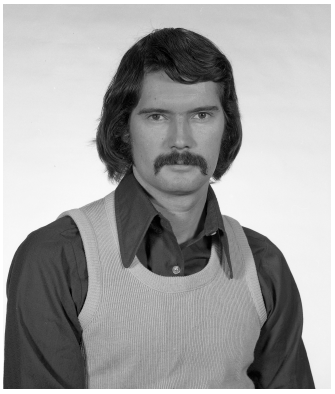
Ray Sheldon

Doug Sameoto



Tim Lambert

Subba Rao Durvasula



Al MacDonald

Ray Rantalla

Some program highlights:

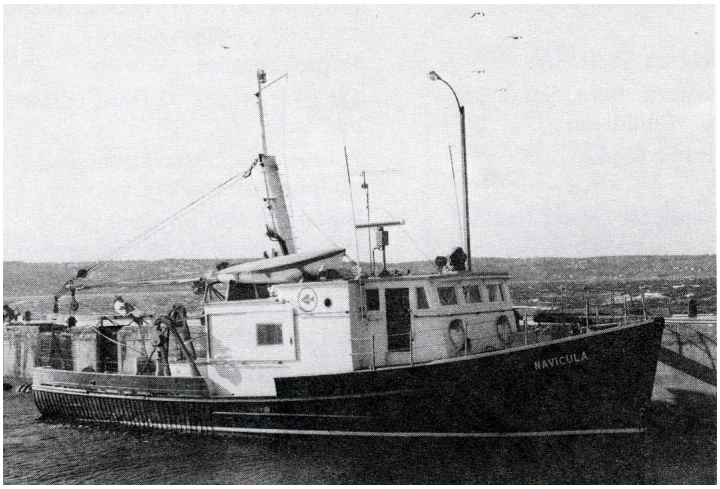
- The St. Margaret's Bay ecosystem study was expanded to include a project to measure the productivity and detritus dynamics of rockweed, kelp and sea grass (Mann).

1968

At the national level, the Fisheries Department and the Forestry Branch of the Department of Forestry and Rural Development were merged to create the new Department of Fisheries and Forestry (i.e. Fish and Chips) which included FRB.

There were further name changes at BIO this year. The Dartmouth Laboratory of FRB was officially renamed the Marine Ecology Laboratory (MEL). This name was suggested to Lloyd by Vivian Srivastava. Although this was the year that this name was assigned, 1965 has always been accepted as the birthdate of MEL because it was the year that AOG was granted independent laboratory status, began to report directly to the Chairman of FRB in Ottawa and Lloyd arrived as director. 1968 was also the year that the MSB Laboratory was renamed the Atlantic Oceanographic Laboratory (AOL). For almost twenty years, MEL and AOL were sister labs at BIO.

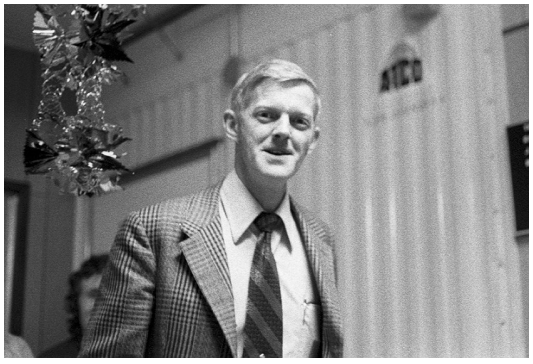
In order to provide experimental facilities for the expanding biological program, the Fish Lab was built on the shore of Bedford Basin and equipped with various holding and experimental tanks with running salt and freshwater. Meanwhile, space was getting tight in the main building so construction began on a temporary trailer complex behind the Fish Lab to provide overflow office and lab space for newly arriving MEL staff. A field station was established at Boutilliers Point and the newly constructed *Navicula* was delivered, both to support the substantial St. Margaret's Bay program. In addition, MEL took over the responsibility of managing the Ellerslie shellfish field station on PEI from the St. Andrews Biological Station. At the time, this station was managed by Reid Loggie.



Navicula

Ellerslie shellfish field station on PEI

Staff now numbered 50. Arrivals this year included Barry Muir, Madhu Paranjape, Martin Thomas and Roy Drinnan. Barry, a fisheries biologist, arrived from the University of Hawaii. He had earlier done a doctorate in fish physiology at the University of Toronto. Roy was a shellfish biologist who took over the management of the Ellerslie station when Reid Loggie departed.



Barry Muir

Madhu Paranjape

Some program highlights:

- An integrating radiometer was built to measure submarine light energy as part of phytoplankton primary productivity studies (Platt).
- Studies were carried out on the formation of organic particles in seawater (Sheldon).
- The influence of humic substances on phytoplankton growth was studied (Prakash).
- New methods were developed to use RNA to estimate the biomass and productivity of zooplankton (Sutcliffe).
- Studies of macroplankton and ichythoplankton were initiated (Sameoto).
- Effects of feeding on metabolism and enzyme activity in fish were studied (Smith).
- Studies of the irrigation of fish gills were begun (Muir).
- Surveys of the benthos of Bideford River, PEI were conducted (Thomas).
- Studies were initiated on shellfish production in shallow coastal systems (Drinnan).

1969

After five years in Ottawa, Ron Hayes retired as Chairman of FRB and moved back to Dalhousie to become the Killam Professor of Environmental Science. Subsequently he was involved in establishing the School of Resource and Environment Studies (SRES) and writing a book on the management of science in Canada (Hayes 1973). He was replaced as Chairman of FRB by John Weir.

This year, Lloyd Dickie was loaned to the Science Council of Canada to undertake a study of marine science and technology in Canada in collaboration with Bob Stewart of the University of British Columbia. During his absence, Ron Trites took over as acting director. Their report (Stewart and Dickie 1971) contains a number of observations and recommendations pertinent to MEL.

They observed that the field of marine activities had changed markedly in Canada during the previous ten years. The development of an offshore oil and gas industry was well underway and had great potential. There was also great potential for expansion in the fishery and marine transportation industries. In addition, there were growing new demands in recreation, pollution control and climate prediction and control. They also saw a need for increased participation by Canada in international scientific activities.

They concluded that a serious reconsideration of the place of marine science and technology in our total national picture was needed and proposed a national marine development program for the 1970s with four elements:

- Establish a policy to develop a major marine-oriented secondary industry, based on marine science and technology and industrial expertise, to serve the growing offshore oil and gas, fisheries, recreation and pollution control industries.
- Establish a policy to develop legal and organizational mechanisms which would make marine activities effective instruments in the promulgation of both national and international policies.
- Establish a policy to develop marine science and technology as an integral part of the field of environmental science.
- Establish a policy to extend the definition of environmental quality control to include climatic change.

They felt that Canada was in an especially favourable position for developing the marine area as a special national effort for it had an excellent starting point given its existing scientific and educational institutions and large markets available for its products. However, the organizational and administrative mechanisms and level of funding were not sufficient to realize these opportunities. They recommended a number of specific steps that the federal government should take to institute an effective national marine science and technology program:

- Immediately set up an advisory board to consider the merits of their proposed national program for the 1970s and as the basis for formulating a national policy.
- Develop a strong technically self-reliant Canadian secondary industry by setting up a Canadian Ocean Development Corporation as a crown corporation to manage this development.
- Revamp the administrative mechanisms and assignment of organizational responsibilities used to promote the growth of scientific and technological knowledge.

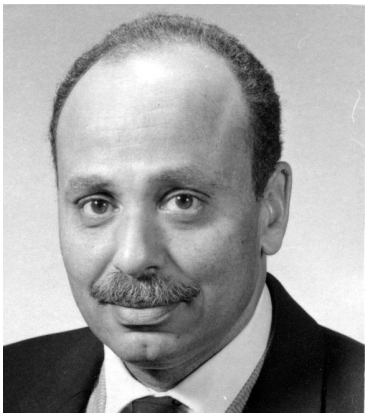
They recognized that these activities would require increased resources for marine science and technology in the university, government and industry sectors and recommended that federal expenditure be doubled by 1980.

They also expressed their views of the relative roles of universities, government research labs and industry in marine science. Universities with their academic freedom are a major source of new ideas and a natural home for basic research. They also play a major role in training new scientists for government labs and industry. In this regard, they explicitly mentioned the success of the Institutes of Oceanography at UBC and Dalhousie and recommended that attention be given to increase training in ocean engineering. In contrast to universities, government labs have a job to do, are mission-oriented and, while can conduct basic research, usually focus on applied research and development. They argued that there should be room for some basic research in government labs, and suggested that this be on the order of 30%. Government labs need to attract and retain creative scientists who are not restricted to working on only routine problems. This would

enable government research labs to respond effectively to new challenges as they appear. They also noted the advantage of locating several government labs with related interests but different goals together in close proximity to universities to create a sufficiently large and stimulating intellectual community. Halifax/Dartmouth was given as a prime example.

Lloyd continued to apply these ideas to the running of MEL when he returned from Ottawa and resumed his director's role.

New arrivals this year included Mohammed Hassan, Dave Krauel, Ann Orr, Ken Freeman and Peter Beamish. A fire caused by a gas explosion damaged one of the trailers behind the Fish Lab.


Mohammad Hassan


Dave Krauel


Ken Freeman


Ann Orr


Peter Beamish

Some program highlights:

- A detailed study of the spring phytoplankton bloom was conducted in St. Margaret's Bay. The disciplines of physics (underwater optics), chemistry (element flux), and biology (species taxonomy) were

simultaneously brought together to address questions in plankton ecology (Platt and Durvasula).

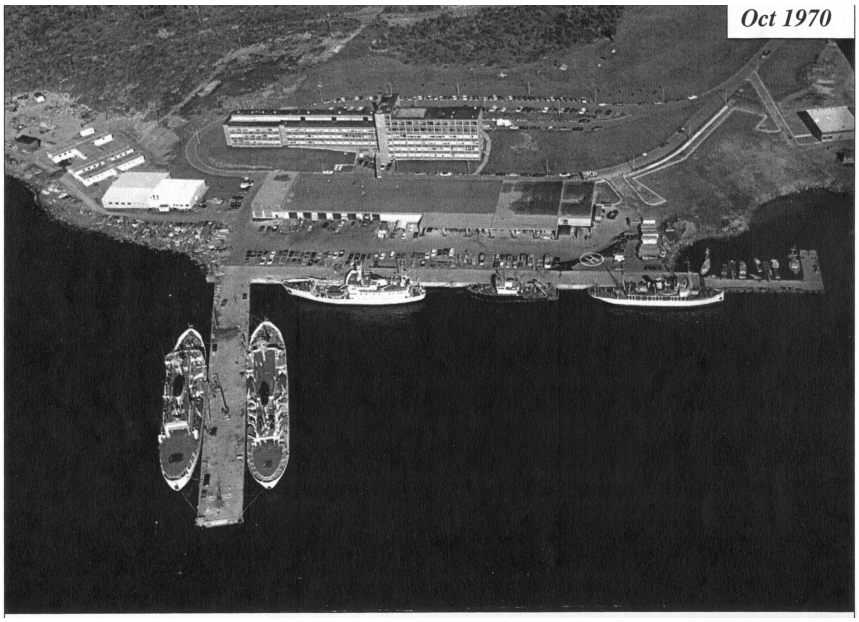
- A second coastal ecosystem program was initiated, this time in Bedford Basin and Halifax Harbour, to explore the effects of nutrient enrichment from untreated sewage released by Halifax and Dartmouth. The fluxes of nutrients and plankton through the Narrows were determined in a collaborative effort between physical oceanographers and biologists. A 25-hour phytoplankton budget for Bedford Basin was developed that balanced within 7%. The properties of this system were compared to those in nearby St. Margaret's Bay, thereby marking the beginning of comparative studies of different coastal ecosystems (Trites, Platt, Conover, Mann).
- The physical oceanography of the Margaree Estuary was studied (Krauel).
- Studies were begun to examine the effects of Langmuir circulation on the distribution of organic particles in oceanic waters off Bermuda (Sutcliffe).
- 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, for the first time, synoptic surveys of phytoplankton distribution could be conducted by ship over large areas (Platt).
- In collaboration with the Halifax Fisheries Research Laboratory (HFRL), a research program was initiated on short notice to investigate the environmental impacts of an accidental discharge of elemental phosphorus which caused extensive fish kills in Long Harbour and Placentia Bay, NL (Trites, Fletcher, Addison).

1970

The 1960s had been a period of growing environmental awareness triggered by events such as the publication of Rachael Carson's *Silent Spring* in 1962 and the Torrey Canyon oil spill in 1967. The need for new Canadian research programs to investigate the effects of human activities on marine ecosystems was clearly recognized. FRB responded by establishing two pollution groups, one on each coast. The east coast group was set up as the Environmental Quality Division within MEL. Apparently some in FRB felt this unit should have been located in St. Andrews which already had some pollution research underway. However, this new group was obviously better situated at BIO with its broad oceanographic expertise, expanding facilities and support services. Don Gordon was recruited by Lloyd from the Department of Oceanography at the University of Hawaii to head this new division. The west coast group was established in West Vancouver, BC and headed by Mike Waldichuk. In time it morphed into the Pacific Environment Institute.

At the start of the new fiscal year, FRB lab directors across the country lost their separate status as an employer. Previously they were able to hire staff directly but from now on all hiring had to be done through the Public Service Commission in accordance with their policies and the associated red tape. This move slowed the recruitment of new staff and marked a first step along the path of increasing centralization under Ottawa. At the same time, government budgetary restrictions together with a shift in emphasis in government science policy from natural science research to sociological and economic studies brought a virtual halt to FRB expansion.

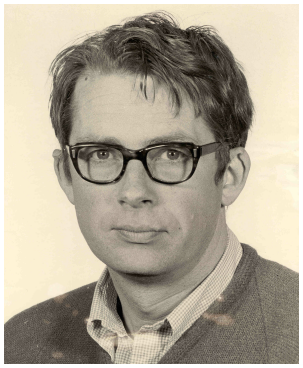
The Fish Lab and the trailer complex were expanded to accommodate the new Environmental Quality Division. The FRB Gaspé Fisheries Experimental Station was closed and several truck loads of laboratory equipment and supplies were transferred to BIO to be used by the Environmental Quality Division in setting up its new research program.



BIO in 1970 showing the expanded Fish lab and trailer complex

Other new arrivals included Harry Buck, Marie Sweet, Richard Addison, Garth Fletcher, Steve Kerr, Peter Vass, Doug Willis, Maurice Zinck, Lorraine (Schnare) Paradis, Donna (Darrow) Sameoto, and Dan Ware. Richard and Garth moved over from the Halifax Fisheries Research Laboratory while Steve had just completed his PhD at Dalhousie and Dan had just completed his PhD at UBC. Total MEL staff now numbered 59.

While developing a funding request for improvements to the Ellerslie field station, an extra zero as added by mistake to the request. This was never detected and Ottawa approved the request at the full amount! As a result, the renovations, including a motel for visitors, were much more extensive than originally planned.



Don Gordon

Richard Addison

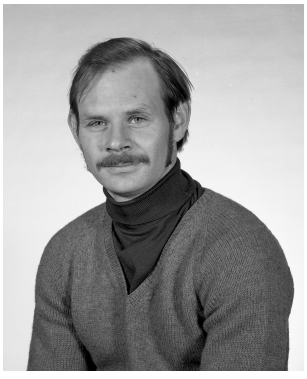
Steve Kerr

Peter Vass

Maurice Zinck

Lorraine (Schnare) Paradis

Donna (Darrow) Sameoto



Dan Ware

Some program highlights:

- Several MEL staff participated in parts of the Hudson 70 Expedition. This major eleven-month cruise sailed down the Atlantic, through the Drake Passage, up the Pacific and back home through the Northwest Passage (Wadhams 2014). It was the first circumnavigation of the Americas by any ship. Studies included the abundance and size distribution of particles in seawater, zooplankton ecology and bioacoustics (Sheldon, Sutcliffe, Prakash, Conover, Paranjape, Freeman and Beamish).
- On short notice, staff responded to the *Arrow* oil spill in Chedabucto Bay by participating with other BIO scientists in the Operation Oil clean-up exercise. Numerous short-term scientific investigations were conducted to investigate the behaviour and effects of Bunker C fuel oil in cold-water environments (Trites, Loring, Conover, Peer, Thomas).
- A long-term research program was initiated to investigate the distribution, behaviour, fate and ecological effects of chlorinated hydrocarbon contaminants (e.g. DDT, PCBs) in marine ecosystems (Addison, Kerr).
- Laboratory studies of mackerel biology were initiated (Muir, Lambert).
- Studies of marine bio-acoustics studies were begun (Beamish).

1971

This year marked major changes at the Ottawa level that rippled down to the regions. Responding to the increasing public awareness of the importance of emerging environmental issues, the federal government created the Department of the Environment (DOE). This new department incorporated most of the FRB and MSB components at BIO, including ships. 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) and merged to form the Atlantic Geoscience Centre (AGC) with Bosko Loncarevic as director. Bosko now joined Bill Ford and Lloyd Dickie around the table on the BIO Directors Committee.

A formal opening ceremony for the expanded trailer complex was held and attended by numerous dignitaries. Addresses were given by Robert Shaw, the Deputy Minister of the Department of Environment, and John Weir, the Chairman of the Fisheries Research Board. Robert Shaw cut the ribbon.

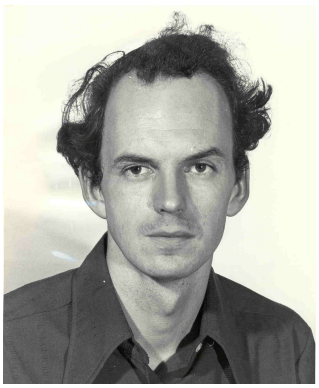
New arrivals this year included Barry Hargrave, Roy Edmonds, Paul Vandall, Paul Keizer, Nick Prouse, Jackie Dale and Georgina Phillips. Barry arrived after completing a PDF at the University of Copenhagen, having earlier received his PhD from the University of British Columbia. Paul Keizer had just earned his masters degree in physical chemistry at Dalhousie while Nick had just completed his masters in marine biology at Guelph. Jackie had

previously worked for Charlie Castell at the Halifax Fisheries Research Laboratory. In addition, Dick Brown of the Canadian Wildlife Service (CWS) arrived at BIO to initiate studies of the pelagic ecology of marine birds. He had earlier done a PhD at Oxford under the tutelage of Niko Tinbergen (who shared the 1973 Noble Prize in Physiology). In 1966, while a PDF at Dalhousie, he had started to join BIO cruises to make seabird observations and so was already familiar with the Institute.

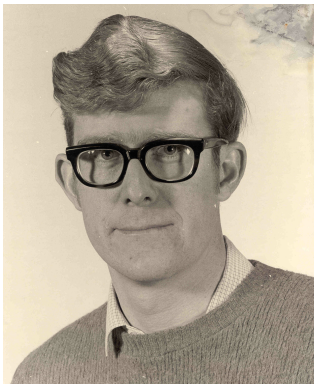
Official opening of expanded trailer complex, June 1971.
John Weir (Chairman of FRB), Dave Idler (Halifax FRB lab) and Lloyd Dickie

Official opening of expanded trailer complex, June 1971.
Ribbon cutting by Robert Shaw (Deputy Minister, Department of Environment)

A new group of scientists from the Resource Development Branch of the Atlantic Fisheries Service, headed by Bob Cook, was established at BIO in the expanded trailer complex to investigate applied pollution issues.

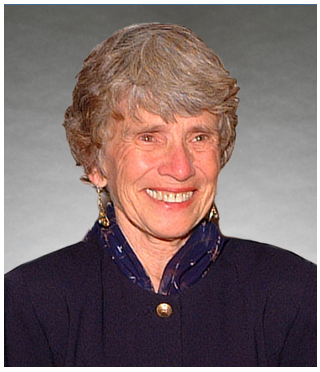


Barry Hargrave



Paul Keizer

Nick Prouse



Jackie Dale

Georgina Phillips

During the early 1970s there was excellent funding for summer students and large numbers were hired to assist with field and lab work. This provided excellent training for prospective staff and several students did eventually join MEL after completing their degrees.

Some program highlights:

- Stimulated by the *Arrow* oil spill in Chedabucto Bay, a long-term research program was initiated to investigate the distribution, behaviour, fate and ecological effects of petroleum hydrocarbons in marine ecosystems with a focus on cold water environments (Gordon, Keizer, Prouse, Hargrave, Dale).
- The Halifax-Bermuda Section program was initiated which built upon the previous Halifax Section program conducted by BIO physical oceanographers. Five monitoring stations were established on the shelf, in slope waters, in the Gulf Stream and in the Sargasso Sea to study various pollutants, non-living organic carbon and other chemical and biological properties throughout the water column. These stations were sampled approximately every three months over two years using BIO vessels, with port calls in St. Georges, Bermuda. Numerous other BIO staff participated, as well as Dalhousie staff and students (Gordon, Keizer, Prouse, Dale, Sutcliffe, Orr).

- A project was initiated to develop acoustic methods for mapping the distribution of zooplankton in shelf and slope waters using towed dual frequency acoustic sounders (Sameoto).
- Benthic surveys were conducted at Boat Harbour near Pictou before and after the discharge of wastes from the new bleached kraft paper mill at Ambercrombie Point. A marked change in the composition of the benthic community was detected and attributed to the flocculated mill wastes. This was the first time at BIO that benthic communities were used to monitor the effects of human activities on marine ecosystems (Peer).
- The Canadian Wildlife Service (CWS) initiated a seabird research program to catalogue breeding colonies along the Atlantic coast and eastern Arctic, measure the productivity and other primary demographic parameters of representative species of differing ecological and collect quantitative observations of the distributions of seabirds at sea to show features of water habitat usage and identify areas of particular importance (Nettleship, Brown).

1972

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

This year saw the publication of an internal report proposing a departmental science policy for the newly created Department of Environment written by Peter Meyboom who was then employed by the Treasury Board (Meyboom (1972). The many recommendations included:

- There should be stronger links between government scientists and policy makers.
- Environmental data cannot be secret and should be made public as soon as possible.
- Government scientists concerned with environmental matters should be pragmatic and consider the Canadian public as their prime audience, not other scientists or industry.
- Since the majority of research projects are generated by the research scientists themselves, it is suggested that a more rigorous process of program formulation be adopted starting with ministerial statements about Department objectives.
- The Department should address itself to the design of a national policy system that will recognize and resolve the conflicting uses of the environment.
- Departmental relations with universities should primarily be determined by educational needs and only secondarily by research needs.

- It is suggested that all research and development on the acquisition, transmission and display of environmental data be done in industry.
- The Department should form temporary organizations to deal with specific problems which would be stationed in Ottawa with mobile field quarters of trailers and houseboats. Accommodation needs of regional programs should be met as much as possible by rental rather than construction.

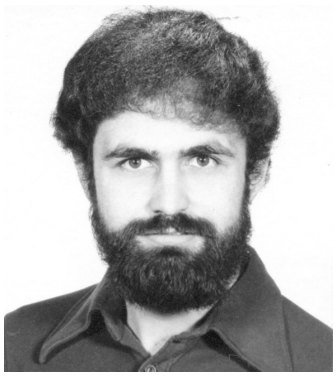
Fortunately, not all of these policy recommendations were acted upon but they illustrate the mind set of Peter Meyboom as he made his way up the Ottawa bureaucracy and eventually became the Deputy Minister of DFO in 1985 and the principle architect in the demise of MEL in 1987.

This was the year that the Environmental Protection Service (EPS) was created in the new Department of Environment. EPS subsequently established an Environmental Quality Laboratory at BIO under its new Surveillance and Analysis Division which was headed by Bob Cook and housed in the Fish Lab and trailer complex. Many of the staff transferred over from the Resource Development Branch. This new lab was staffed and equipped for analytical chemistry, microbiology and aquatic toxicology. Staff were also responsible for shellfish monitoring and surveillance. Close working relationships developed with MEL staff in the Environmental Quality Division who shared the same facilities.

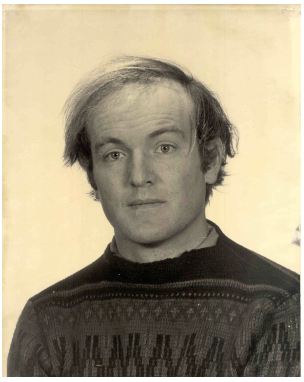
BIO Directors in 1972
Bosco Loncarevic (AGC), Lloyd Dickie (MEL) and Bill Ford (AOL)

On the spring cruise along the Halifax-Bermuda Section, the *Dawson* experienced four days of severe weather with hurricane force winds. The ship hove to and most staff retreated to their bunks. Very few were able to eat, but a lot of Bermuda rum was consumed. Only about 5% of the program could be carried out. Years later, crew members still said it was the worst cruise they had ever experienced (Gordon, Dickie, Conover, Keizer, Prouse, Pocklington, Brown, Riley and Fournier).

Ken Mann departed MEL to become the Chairman of the Biology Department at Dalhousie. However, he continued his MEL research programs with the assistance of numerous graduate students so that close ties with MEL were maintained. With his departure, Trevor Platt took over as head of the Biological Oceanography Division. New arrivals this year included Ken Denman, Gareth Harding and Jeff McRuer. Ken came from UBC while Gareth arrived from Dalhousie after completing his doctorate degree under Gordon Riley. At the end of 1972, total MEL staff numbered 78.



Ken Denman



Gareth Harding

Jeff McRuer

Some program highlights:

- Studies of mesoscale inhomogeneities were conducted (Hassan and Trites).
- Work began to explore the use of remote sensing in ecological studies (Vandall).
- Led by Max Dunbar from McGill, several workshops were held at BIO to discuss the idea of conducting a full-scale ecosystem investigation of the Gulf of St. Lawrence. However, this ambitious undertaking never got off the ground (Dunbar, Dickie, Trites).
- A third coastal ecosystem study was initiated in Petpeswick Inlet down the Eastern Shore. This included studies of the contributions of salt marshes and eelgrass to system productivity. The reasons for the differences between the Petpeswick Inlet, Bedford Basin and St Margaret's Bay ecosystems were explored, thus expanding comparative studies of ecosystem structure and processes in coastal waters (Mann, Sheldon, Sutcliffe).
- Studies were initiated to examine the effects of the St. Lawrence River discharge on fisheries production in the Gulf of St. Lawrence, Scotian Shelf and Gulf of Maine (Sutcliffe).
- A long-term program was begun to study pelagic and benthic exchanges in marine ecosystems with the initial studies being conducted in Bedford Basin (Hargrave).

- 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 (Drinnan).
- Using particle data collected using a Coulter Counter on the Hudson 70 Expedition, as well as data from the scientific literature, it was observed that to a first approximation, on a logarithmic scale, roughly equal concentrations of biomass occurred over the whole range of oceanic food webs from bacteria to whales. This unexpected result led to the development of the biomass spectrum theory, another unique MEL contribution to understanding marine ecosystems in the world ocean (Sheldon, Sutcliffe, Prakash).
- This new biomass spectrum theory was applied to predict the potential number of monsters that might exist in Loch Ness (Scotland, UK) from fish production data. The monster density was estimated to be 10-20 individuals (Sheldon, Kerr).
- In collaboration with the Arctic Biological Station, DDT-group and PCB concentrations were measured in blubber of a ringed seal population at Ulukhaktok, NWT. It was concluded that female seals were good candidates for long-term monitoring of trends in DDT-group and PCBs (and presumably other organochlorines with similar physico-chemical properties) since they essentially 'sample' their environment and then discard a significant fraction of the sample during lactation (Addison, Smith).
- A survey of mackerel eggs and larvae was conducted in the southern Gulf of St. Lawrence using the *Harengus* and *Sackville*. High concentrations were found in St. Georges Bay and it was concluded that this would be an ideal site to establish a field program to study the early life history of mackerel (Lambert).

1973

After a 75-year history of excellence in fisheries research, the Fisheries Research Board (FRB) was relieved of direct control over its research programs and facilities and demoted to being solely an advisory body. The many reasons behind this decision are reviewed by Anderson (1984). Jack Davis, Minister of the Department of Environment at the time, presented his views on the future role of FRB to a Board meeting in January of 1973. He felt that the Board should bring its functions more in line with the broad objectives of the Fisheries and Marine Service, especially to improve effort in fisheries research and strengthening Canada's bargaining position in the international fisheries field. He wanted results that were more comprehensible at the political level. Ken Lucas, the newly appointed Senior Deputy Minister of the Fisheries and Marine Service, was also present and added the comment that research programs should not have separate objectives since research was only an activity and not an end in itself (Anderson 1984). Thus was the mind set of the Ottawa managers at this time making these decisions.

To place the official reasons for this decision in their historical context, one must examine the evolution of organization structures and policy decisions during the preceding five years (1968-1973). As reviewed by Anderson (1984), this was a particularly turbulent period with many changes for Canadian government organizations concerned with fisheries and other natural resources. These organizational changes had radically altered the environment in which FRB operated. In 1968, the Board had considerable support and good relations with its major clients (universities, the fishing industry and the Ministry of Fisheries) and could securely function as mandated to provide research support for the fisheries and contribute generally to the advancement of scientific knowledge. At this time the Board had eighteen members; ten from the universities, seven from the fishing industry and one from government. It set objectives and policies for its ten research establishments across the country that employed a staff of almost one thousand. However, after 1968 there was a general trend in the federal structure to integrate all agencies involved with renewable resources that placed FRB in a difficult position that questioned its traditional functions, as well as its relations with other organizations. This departmental restructuring led to the development of overlapping policy perspectives because each agency had its own philosophy, policies and views of fisheries problems.

The growing effects of pollution on the environment at the end of the 1960s were becoming increasingly evident. FRB had seen pollution research as a major area in which it should become involved and began to develop expertise for tackling major environmental issues affecting fisheries. In its brief to the Lamontagne Commission in 1968, the Board had requested that its mandate be expanded to include some responsibility for water resources but this was not acted upon.

The establishment of the new Department of Environment (DOE) in 1971 was predicated on the relatively new concept of resource policy, which in turn relied for its existence on the political strength of the environmental movement. The bringing together of a wide range of formerly diverse policies in DOE was rationalized in terms of more efficient resource management. In his introduction to the bill to creating DOE, Jack Davis, Minister of Fisheries and Forestry, commented that the environment was the biggest challenge facing Canada in the 1970s and that emphasis must be given to the wise management of our living resources — fish, forests, birds, wildlife — and the renewed quality of our water, soil and air. As part of DOE, FRB had responded to this new policy direction by expanding research activities in the areas of renewable resources and environmental quality, despite a severely restricted budget.

The government efficiency movement took form in the Planning, Programming and Budgeting (PPB) approach championed by the Treasury Board. Planning, as conceived by this approach, required centralization of control and annual accountability. The position of the Treasury Board on the role of government

science, as given in 1968 to the Lamontagne Commission, was that science is not regarded as a thing in itself but rather as a means to an end. In general, particular scientific projects should not be examined on their own merits but rather as components of federal programs which have defined departmental objectives.

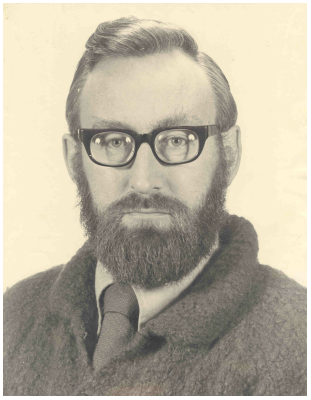
The science policy movement, which during this period included the Science Secretariat, the Science Council, the Lamontagne Committee and the Ministry of State for Science and Technology, provided a policy perspective in which fisheries and resource questions could be examined. Although the Science Council preached coordination rather than integration, its general recommendations on resource policy included two recommendations that, in effect, put in question the FRB's traditional structure and functions. The Council recommended that a larger proportion of research be done in the private sector and that mission-oriented departments be given more control over funding research. The Lamontagne Commission recommendation to implement the Make-and-Buy policy put into further question the very foundation of the principle underlying the FRB which was to build its own in-house expertise.

In summary, as reviewed by Anderson (1984), the integration of FRB into DOE, and the integration of fisheries research and resource management policies, had created a situation in which the traditional functions of FRB had become difficult to carry out. Although the Board attempted to adapt to this new environment, proponents of government integration and efficiency occupied most of the senior positions in Ottawa and carried the day. Hence FRB was relieved of its research responsibilities. Fortunately, MEL remained as an independent laboratory and, along with AOL, became part of the Fisheries and Marine Service. Both directors now reported to Ken Lucas in Ottawa. This change did not have much of an immediate impact on MEL and by and large work continued as usual.

This was the year that Ron Hayes published his book entitled *The Chaining of Prometheus: evolution of a power structure for Canadian science* (Hayes 1973) which addressed recent changes in the management of federal government science. Prometheus was a Greek god known for his intelligence, a champion of mankind and author of arts and sciences. Hayes described how increasing top-down management and focus on planning, programming and budgeting (PPB) while he was in Ottawa had drastically changed science policy in Canada. He argued that first class science could not be planned because its essence was discovery and one could not predict the outcome.

New arrivals this year included John Vandermeulen, Paul Brodie, Ross Shotton and Paul Dickie. John arrived after completing a PDF at Duke University and had previously done a PhD at the University of California in Los Angeles. Paul had just completed his PhD at Dalhousie and had previously worked at the

Nova Scotia Museum of Natural History. Ross had earlier earned a masters degree from the University College of North Wales in Anglesey, UK.


John Vandermeulen


Paul Brodie


Paul Dickie

Some program highlights:

- Using new equipment designed at BIO, water temperature and fluorescence were measured simultaneously at one-second intervals from a moving ship to provide exciting new information on the spatial complexity of marine phytoplankton over the scale of tens of kilometers the St. Lawrence Estuary (Denman).
- A program was initiated to explore the cyclical trophic relationships between kelp, sea urchins and lobster (Mann).
- The St. George's Bay larval fish field program began and gradually expanded into a long-term multidisciplinary study of the entire coastal ecosystem (Ware, Lambert, Drinkwater, Sheldon, Hargrave, Harding).
- A long-term program of marine mammal energetics was initiated (Brodie).

1974

After nine years at the helm and building MEL into a major marine ecological laboratory with an international reputation for excellence, Lloyd Dickie was ready for some new challenges. He stepped down as Director and moved across the harbour to become chair of the recently created Department of Oceanography at Dalhousie (which had replaced the Institute of Oceanography), taking over from Gordon Riley. He also became the Director of the newly created School of Resource and Environmental Studies (SRES) that had been recently established under the leadership of Ron Hayes. A grand outdoor party was held behind the trailers to say goodbye at which he was presented with a 13' Gates canoe and a set of canoe paddles carved by Ken Freeman. Barry Muir, who had been serving as assistant director, took over the helm as acting director.

Lloyd Dickie farewell, June 1974

Lloyd Dickie farewell, June 1974

The expansion of the MEL program continued and by the end of the year the total number of staff was 84. Planning began for major additions to the BIO campus, including a new office and laboratory wing between the main building and the Fish Lab to accommodate MEL staff which were in the aging trailer complex.

New staff this year included Sidney Crabtree, Pat Ahern and Marilyn Baxter.

Some program highlights:

- For the first time, the spatial distribution of phytoplankton on the Scotian Shelf was observed using Batfish mounted with a CTD and fluorometer. In addition, theoretical investigations were undertaken to establish the critical scales of patchiness under different physical and

biological conditions and the effects of turbulence on phytoplankton production was explored in Bedford Basin using Octuprobe (Platt).

- Studies of discharge records of the St. Lawrence River and yearly catch of several commercial species in the Gulf of St. Lawrence suggested 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 suggest the possible influence of environmental factors on fish production (Sutcliffe).
- High frequency sonar was used to locate high concentrations of euphausiids (krill) in the Gulf of St. Lawrence (Sameoto).
- 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 named ECOLOG (Dickie, Dowd, Shotton).

ACTING DIRECTOR YEARS (1974 – 1977)

By now, the expansion years were largely over and MEL had developed a broad ecological program that covered all parts of the marine food web ranging from phytoplankton to marine mammals, including physical oceanographic processes and chemical contaminants. Field programs were being carried out in a variety of environments ranging from coastal waters to the open ocean. Staff worked in close collaboration with AOL, AGC and university scientists. By and large funding was adequate, ship time was easy to get and staff were able to attend international meetings, workshops and conferences with few restrictions. Morale was high. These were indeed exciting and productive times for all research at BIO.

The departure of Lloyd Dickie to Dalhousie marked the beginning of a four-year period during which MEL had four successive acting directors: Barry Muir, Don Gordon, Trevor Platt and Richard Addison. Fortunately, the general working environment remained relatively stable during this period and most programs continued as usual. Martin Blaxland and the office staff looked after most of the administrative matters and helped keep the lab on course. In true BIO fashion, Bill Ford, Ced Mann, Reg Gilbert and other key BIO colleagues provided sage advice as needed along the way.

1975

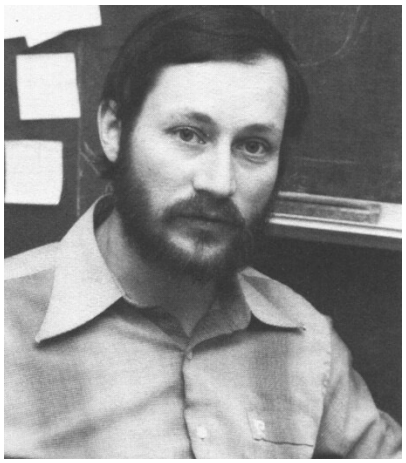
The Honourable Roméo LeBlanc, the Minister of State for Fisheries, announced that $18 M had been approved for expanding BIO facilities over the next four years. Soon after, the Department of Environment (DOE) was renamed the Department of Fisheries and Environment (DFE) and the Honourable Roméo LeBlanc was appointed Minister. This move further illustrated the increasing priority that the federal government was giving to fisheries.

The renamed department then began to revamp its management framework which resulted in major changes in the organization of the Fisheries and Marine Service. The principal parts of the former fisheries operations organization, the Resource Development Branch, the St. Andrews Biological Station and the Halifax Fisheries Research Laboratory were placed in the new Fisheries Resource Branch. After serving a year as Acting Director of MEL, Barry Muir moved to Halifax to become the Maritimes Director of this new branch. Don Gordon replaced him as Acting Director of MEL.

At the same time, the Marine Science Branch (MSB) in Ottawa was renamed Ocean and Aquatic Sciences (OAS) and Art Collin, a former AOG physical scientist, was appointed as the Assistant Deputy Minister (ADM). A degree of decentralization from Ottawa was achieved by the appointment of new Regional Directors-General (RDGs) for OAS responsible to Art Collin in Ottawa. Bill Ford was appointed as the Atlantic DG and Ced Mann replaced him as Director of AOL. Art and Bill were close friends and worked well together. Bill would go to Ottawa to act for Art when needed and Art spent some of his vacation time every year cruising with Bill along the coast of Nova Scotia. The Institute-wide technical support functions, previously managed by AOL, were incorporated into a new branch under OAS named Institute Facilities and Reg Gilbert was appointed as manager. National meetings of regional OAS managers were held in Ottawa on a regular basis but separate from the national meetings of fisheries research managers.

Because of the nature of its research program and being located at BIO, MEL fortunately had the choice of deciding where to go in the new organization. It could move over to the new Fisheries Resource Branch under Barry Muir with the St. Andrews Biological Station (SABS) and Halifax Fisheries Research Laboratory (HFRL) or it could join OAS under Bill Ford along with AOL and Institute Facilities. At the request of Bill Ford, Don Gordon did a quick poll of MEL staff. The unanimous decision was to join OAS because of its oceanographic and multidisciplinary focus. Barry Muir was disappointed and most likely somewhat hurt to be rejected by his former colleagues. However, this decision was never regretted at the time but may have come back to haunt us in 1987.

New staff this year included Ken Drinkwater (who later earned his PhD from Dalhousie in 1987) and Brian Petrie. Brian came from doing a PDF at WHOI after completing his PhD at Dalhousie. He joined the Environmental Oceanography Division but soon after transferred to the Coastal Oceanography Division of AOL.



Ken Drinkwater

Some program highlights:

- Batfish was fitted with a fluorometer to obtain a two-dimensional picture of chlorophyll concentrations in the top 400 m on a continuous basis as it moved horizontally and vertically through the water (Platt, Denman).
- Studies in Bedford Basin demonstrated non-living organic particles were an important food source for small copepods (Poulet).
- A cruise into the Bermuda Triangle was carried out to study the fine-scale distribution of non-living particulate organic matter in seawater (Sheldon, Gordon).
- Moored sediment traps for ecological studies were designed and constructed to determine the settling rate of suspended particulate matter in various coastal bays including Bedford Basin and St. George's Bay (Hargrave).
- Staff began to participate in the Regional Ocean Dumping Advisory Committee (RODAC) to review ocean-dumping applications as required under the new Ocean Dumping Act (Peer).
- The Canadian Wildlife Service mapped the locations of several thousand seabird colonies along the Atlantic coast and in the eastern Arctic from the air, water, and land, and measured the sizes of breeding populations (Nettleship, Brown).
- Using over 60,000 seabird observations made on BIO research vessels on an opportunistic basis over several years, as part of the PIROP program (Programme Intégré de Recherches sur les Oiseaux Pélagiques), the Canadian Wildlife Service produced an atlas of seabird

distributions in the northwest Atlantic. Coupled with the colony survey information, the pelagic distribution data allowed seabirds to be viewed as part of marine ecosystems with their distributions linked to aspects of physical and biological oceanography (Brown, Nettleship).

1976

As a result of these organizational changes, some MEL programs were transferred to the new Fisheries Resource Branch. These included the project developing acoustic methods for fisheries stock assessment (ECOLOG), the shellfish aquaculture program and the operation of the shellfish research station at Ellerslie, PEI. In addition, the Environmental Oceanography Division, which overlapped MEL and AOL, was terminated as an organizational unit and staff were transferred according to their preference to either the MEL Fisheries Oceanography Division or the AOL Coastal Oceanography Division.

Along with others at BIO, MEL 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.

A competition was set up to find a new MEL director. A number of people, including John Steele in Aberdeen, UK, and Dan Livingston at Duke University, were approached informally but were not interested in applying. A competition was held and won by Bob Hamilton, an ecologist at the Freshwater Institute in Winnipeg, who had earlier worked at Scripps in John Strickland's food chain group, but he declined. There was no second choice available at the time so the search continued.

The newly created Marine Fish Division (MFD) in the Fisheries Resource Branch, headed by Ralph Halliday, began setting up at BIO. Many of the staff moved over from St. Andrews while others were freshly recruited. With new resources, this new division proceeded to grow and established an expanded research program to address the demands of domestic fisheries management. Many of the new projects included large-scale fishery surveys which considered ecological factors complementary to ongoing MEL research on food chain dynamics. In addition, the entire Seabird Research Unit of the Canadian Wildlife Service (CWS), headed by David Nettleship, moved into BIO from Ottawa to join Dick Brown. Both these moves further strengthened the scope of biological programs at BIO, in particular at the higher trophic levels, and collaborative ties with MEL were established.

When the dust settled from these changes, BIO continued to function as one community sharing the many common facilities and managed by a committee comprised of the Regional DG, the directors of AOL, MEL and AGC, the Manager of Institute Facilities and the Head of the Marine Fish Division. After

serving as Acting Director for a year, Don Gordon stepped down and returned to the bench in the Environmental Quality Division. Trevor Platt then took over as Acting Director.

The field station at Crystal Cliffs near Antigonish was established in support of the expanding St. Georges Bay ecosystem study. By the end of 1976, the first of the new BIO additions, later to be named the Strickland Building, was nearing completion.

Steve Kerr returned after spending four years with the Ontario Ministry of Fisheries in Maple, ON. Other new staff included Mary Lewis and Pat Lindlay.

Mary Lewis

Some program highlights:

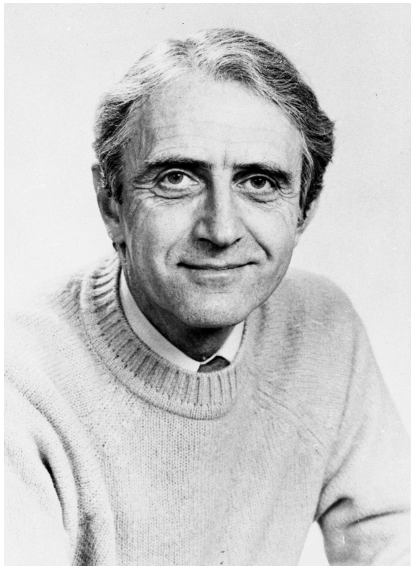
- The mathematical considerations required for analysis of the functional dependence of photosynthesis on irradiance were explored. This work served as a catalyst in primary production research (Jassby, Platt).
- The St. George's Bay larval fish study was expanded to include a mooring and hydrographic program to determine the mean circulation and additional biological studies (Ware, Petrie, Drinkwater).
- MEL staff were involved with the planning of the Shelf Break Dynamics Program on the edge of the Scotian Shelf south of Halifax which was designed to determine the reasons for the zone of high nutrient concentrations and biological activity (Dickie, Smith, Petrie).
- Theoretical work continued on predicting the responses of fish production systems to stressors with emphasis on the community level of response to fishery exploitation (Kerr).
- Studies continued to document the recovery of Chedabucto Bay from the 1970 *Arrow* oil spill. It was discovered that a substantial amount of weathered oil still remained in the intertidal sediments, especially in low

energy environments such as salt marshes, lagoons and estuaries (Vandermeulen, Keizer, Dale, Ahern).

- The five-year Eastern Arctic Marine Environmental Studies program was launched 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 (Platt, Irwin, Paranjape).

1977

Trevor Platt completed his term as Acting Director. Since a permanent director had not yet been appointed, Richard Addison took over as the fourth successive acting director soon after returning from professional development leave at the Institute for Marine Environmental Research (IMER) in Plymouth, UK. While there he had met its Deputy Director, Alan Longhurst, who was leading an ecosystem study of the Severn Estuary and Bristol Channel which was examining the potential impacts of proposed tidal power development. Thinking he might be a good candidate, Richard had mentioned to Alan that MEL was looking for a new director and it just so happened that Alan was not happy with conditions at IMER and was considering other options. Upon return to BIO, Richard spoke with Bill Ford and recommended that he approach Alan and encourage him to apply for the position. Bill did so and soon after Alan came over for an interview and tour of BIO. He already knew some of the MEL scientists and was most impressed with what he saw. It seemed to him that BIO had the ideal form of organization with minimal administrative interference with scientific programs, a sort of federal university (Sherin 2014).



Alan Longhurst

He subsequently applied, won the competition and arrived at BIO by the end of the year. Having previously worked for the West African Fisheries Research

Institute, the New Zealand Department of Fisheries and the US Southwest Fisheries Science Center, Alan came to MEL with a strong fisheries background. With Sir Alistair Hardy, he had also been earlier involved with the development of the Longhurst/Hardy Plankton Recorder, a unique zooplankton sampler designed to be towed by vessels of opportunity.

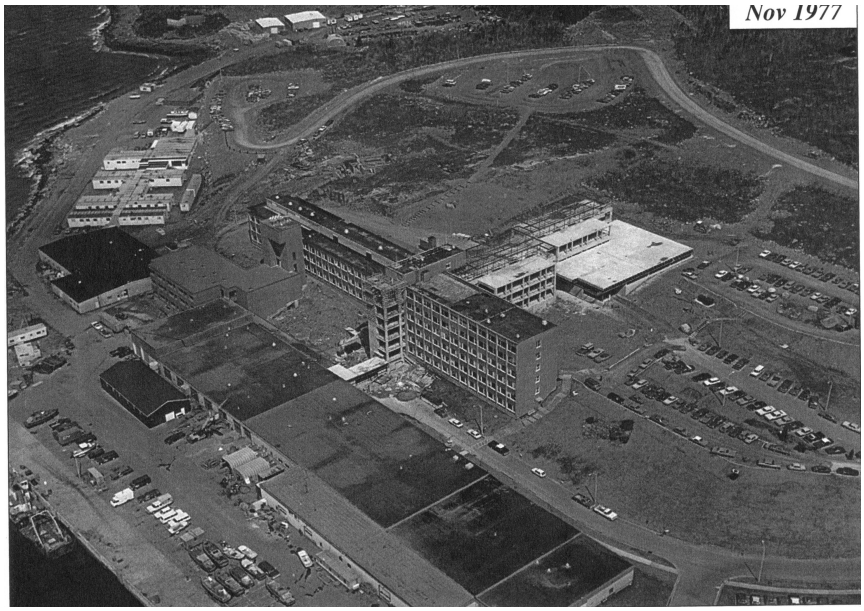
Party at Conover's

This was the year that Canada formally extended its territorial boundary out to 200 nautical miles, thereby creating an exclusive economic zone (EEZ) that encompassed most of the continental shelf and its fisheries resources. The management of fish stocks and marine mammals within this zone had previously been the responsibility of the International Commission of Northwest Atlantic Fisheries (ICNAF), based at BIO. It had made the decisions on appropriate harvesting by both the domestic and foreign fishing fleets operating beyond Canada's twelve-mile limit. With extended jurisdiction, this management responsibility was now transferred to the Department of Fisheries and Environment. However, ICNAF retained management responsibility for fisheries outside 200 nautical miles which included the productive Tail of the Banks off Newfoundland.

These actions had no immediate impact on MEL. Its fish-related research had been focused on understanding fish populations within an ecological context and its staff were not directly involved in fisheries management issues. Before 1977, the fisheries research group in St. Andrews had the mandate to conduct assessment and associated research to determine the distribution and abundance of fisheries in the Gulf of St. Lawrence, Scotian Shelf, and Gulf of Maine and interacted regularly with ICNAF. However, these changes had a profound impact on the new Marine Fish Division (MFD) at BIO which began an expanded fisheries research program and took over from St. Andrews some of the responsibility for providing scientific advice in support of fisheries management within the Maritimes Region. While there were integrated programs dealing with herring and groundfish surveys, MFD focussed on finfish and marine mammal stock assessment while St. Andrews continued to

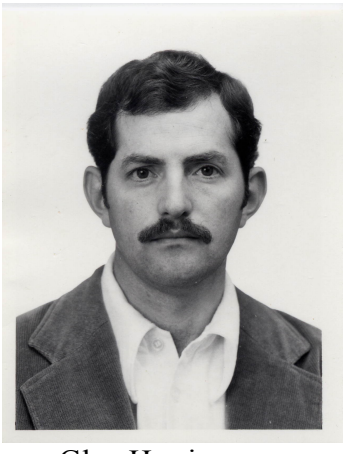
work on pelagic and invertebrate species, as well as on sampling, aging, and survey activities.

The Strickland Building opened at the end of the year. MEL staff moved into the first and second floors while EPS took over most of the ground floor. This allowed MEL to vacate the temporary trailers but some EPS and RDB staff remained.



BIO in 1977 showing completion of the Strickland Building

New staff included Glen Harrison and Dwight Reimer. Glen arrived after receiving his PhD at North Carolina State University and completing a PDF at the Scripps Institute of Oceanography.


Glen Harrison


Dwight Reimer

Some program highlights:

- Studies in Bedford Basin provided new information on the induction of enzymes by zooplankton in response to increasing food supply during a phytoplankton bloom (Mayzaud, Conover).
- Using *Baffin*, a number of MEL scientists worked off Peru as part of a Canadian International Development Agency (CIDA) sponsored Peruvian fishery project. Other BIO scientists were involved as well. Experiments concerning the development and feeding behaviour of anchoveta larvae were conducted at a shore station in northern Peru (Dickie, Ware, Lambert, McRuer).
- MEL organized an international symposium examining the recovery potential of oiled marine northern environments, including Chedabucto Bay. The proceedings were published in a special issue of the Journal of the Fisheries Research Board of Canada (Vandermeulen, Gordon, Mann).
- The BIO Net Sampling System (BIONESS) was developed. BIONESS consisted of ten nets for collecting plankton that could be opened sequentially on command from the surface. It also included instrumentation for simultaneously recording depth, temperature and salinity. This first of a kind instrument allowed sampling zooplankton in different depth layers on a single deployment (Sameoto, Jarosynski, Fraser).
- 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 (Herman, Platt).
- 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 (Hargrave).
- The structure of pelagic food chains and relationships between plankton and fish production were investigated (Sheldon, Sutcliffe, Paranjape).
- Research continued to investigate the influence of environmental factors on fisheries recruitment. Significant correlations were found between freshwater runoff from the St. Lawrence River and the catch of several fish species in the Gulf of Maine (Sutcliffe, Drinkwater).
- The dynamics of chlorinated hydrocarbon contaminants in zooplankton were investigated. It was found that biomagnification through feeding is more significant in these organisms than bioconcentration from seawater (Harding, Darrow, Vass, Drinkwater).

- Studies of grey seals from Sable Island showed that a nursing female could lose about one-third of her total body burden of DDT-group contaminants, approximately the amount accumulated in the previous year's feeding (Addison, Brodie).

LONGHURST YEARS (1977-1979)

Alan Longhurst arrived in late 1977 and soon settled in as the new director of MEL.

1978

Bill Ford retired as the DG of OAS Atlantic and was replaced by Ced Mann. This marked the end of his thirteen-year tenure as the Director of BIO. A farewell dinner and dance was held at the Nova Scotian Hotel. An avid sailor, he was looking forward to spending more time cruising along the coast of Nova Scotia. George Needler then replaced Ced Mann as director of AOL.

As a result of the extended fisheries jurisdiction to 200 nautical miles and the associated diminution in the scientific functions of international fisheries commissions, the Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) was created to provide peer-reviewed advice on fisheries management and a coordinating mechanism for the Fisheries Resource Branch within the Canadian EEZ. It served 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 was based at BIO under the Marine Fish Division and headed for many years by Dianne Geddes. The Director of MEL became a member of CAFSAC and attended the monthly meetings. There was an urgent need for improved fisheries management because of the rapid expansion of the Canadian fishing fleet to fill the void left by the departing European vessels. It was soon evident that this increasing fleet capacity was not only creating socio-economic issues in coastal communities, but was also severely stressing the fish populations and marine ecosystems through overfishing off Atlantic Canada.

New staff included Bill Silvert, Carol Simmons, Liam Petrie, Les Harris and Cynthia Bourbonnais. Bill Silvert had previously been at Dalhousie working with Lloyd Dickie. In addition, Lloyd returned from Dalhousie and joined the Fisheries Oceanography Division as a research scientist.

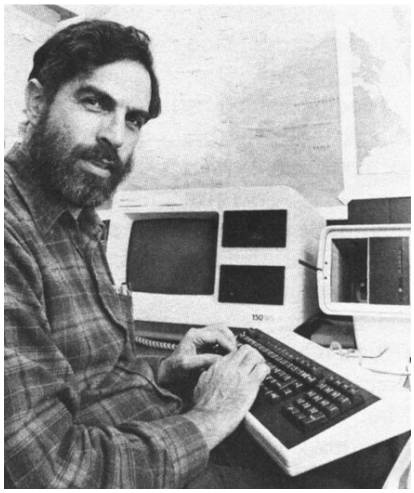
Some program highlights:

- 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 (Platt, Harrison).

- 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 (Conover).
- BIONESS was used to determine the type and abundance of euphausiids found in the acoustic scattering layers in the Gulf of St. Lawrence off Gaspé, QC (Sameoto).
- A collaborative research and training program was established with the lnstituto del Mar del Peru. MEL assisted Peruvian scientists in establishing an experimental facility in Callao and initiating physiological studies on anchoveta larvae (Ware, Dickie).
- Bioenergetic numerical models were developed to describe the flow of energy through an ecosystem to improve understanding of the production dynamics of fish populations (Silvert).
- MEL staff advised French officials in devising a clean-up strategy for the *Amoco Cadiz* oil spill in Brittany and conducted research on the persistence of the spilled oil (Vandermuelen).
- 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 and how it might be altered by tidal barrage construction. Alan Longhurst provided considerable input into the design based on his recent experience of dealing with the same issue in the UK. Focus was placed on Cumberland Basin which 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. This was the first time that MEL addressed the issue of the impacts of physical habitat alteration (Gordon, Hargrave, Keizer, Prouse, Peer, Phillips, Dale).
- Studies on mussel growth and mortality conducted in Bedford Basin found that differences between stocks had a genetic basis (Dickie, Freeman).
- 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 (Sheldon).
- 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 Scotian Shelf where food organisms were most abundant (Brodie).

- Studies 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 (Harding, Drinkwater).
- Further studies added a level of mathematical rigour to the biomass spectrum theory (Kerr, Platt, Denman).
- The Marine Fish Division (MFD) began assisting St. Andrews in running the annual summer bottom trawl groundfish surveys on the Scotian Shelf that had began in 1970. These surveys sampled about 200 stations and provided information of finfish stock abundance, age and size composition. In later years, this program expanded to include spring and fall surveys as well as some surveys in deeper water off the shelf (Halliday).
- The Marine Fish Division (MFD) also initiated the Scotian Shelf Ichthyoplankton Program (SSIP) that ran until 1982. Program design was based on CalCOFI (California Cooperative Oceanic Fisheries Investigation), a monitoring program established at Scripps to investigate the crash in the sardine fishery. The newly acquired fishing trawler *Lady Hammond* was fitted for plankton work, ocean monitoring and computing gear. This large-scale survey program was established because fisheries scientists realized that oceanographic and ecological properties played an important role in year-class success. It mapped the seasonal distribution of the early life history stages of finfish and generated new knowledge on the spatial distribution and timing of spawning for a wide range of fish species. It demonstrated that spawning primarily took place on the offshore banks and that larvae can be retained by oceanographic gyres (Lett, Kohler, O'Boyle).



Bill Silvert

1979

As a result of further organizational changes at the national level, the Department of Fisheries and Environment (DFE) was split into the Department of Fisheries and Oceans (DFO) and the Department of Environment (DOE). The Honourable Romeo LeBlanc was appointed Minister of the new DFO. Both OAS Atlantic and the Fisheries Resource Branch became part of DFO while the other components of DFE became part of DOE.

Art Collin moved to another senior position in Ottawa and Gerry Ewing, who had earlier worked as a hydrographer at BIO, replaced him as ADM for OAS. Soon after OAS was renamed Ocean Science and Surveys (OSS).

Ced Mann departed BIO to become DG of OSS Pacific at the Institute of Ocean Sciences in Sidney, BC. After serving just two years as director of MEL, Alan Longhurst succeeded Ced as DG of OSS Atlantic. Richard Addison then took over as acting director of MEL for a second time and a search for a new permanent director was initiated. Ken Mann, still across the harbour at Dalhousie, was approached and encouraged to apply.

Barry Muir left his position as Director Resource Branch, Maritimes Region to become Director General, Fisheries Research Branch in Ottawa. He was replaced by Jim Stewart.

The Fisheries Research Board of Canada, which had functioned only as an advisory body since 1973, was formally disbanded and the few remaining staff were transferred to DFO. This marked the end of a highly respected and productive Canadian scientific organization whose history has been well documented by Johnstone (1977).

A fire, deliberately set by a commissionaire, inflicted heavy damage on the trailer complex. No one was injured but the RDB, EPS and MFD staff still housed there lost equipment and many valuable records and data sets.

Trailer complex fire, April 1979

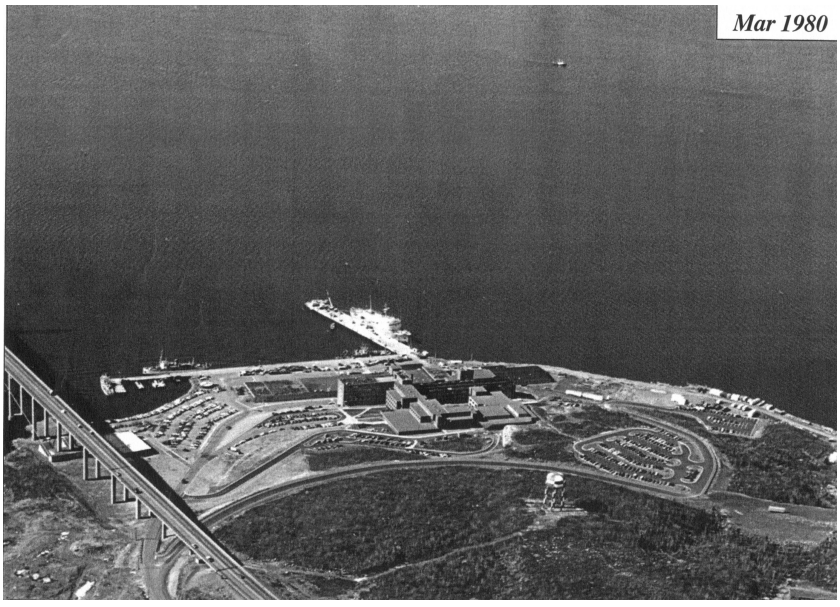
Some program highlights:

- BIO scientists participated in a Canadian delegation led by Gerry Ewing which visited 14 Chinese oceanographic laboratories to discuss possible Canadian-Chinese collaboration in oceanography (Longhurst, Addison, Keen).
- MEL scientists advised the Regional Environmental Emergencies Response Team (REET) on clean-up procedures following the *Kurdistan* oil spill which released 7000 tons of Bunker C oil into the ice-infested waters in Cabot Strait (Trites, Vandermeulen, Peer).
- The Marine Fish Division established the International Observer Program (IOP) to obtain information on fishing vessel activities. Observers were deployed on commercial fishing vessels to record the species and size composition of the catch of each fishing set, time and location of fishing operations and to collect special samples (e.g., diet samples) for BIO scientists (Halliday).

MANN YEARS (1980-1987)

1980

Early in the year, Ken Mann won the competition for Director of MEL and decided to return to BIO after serving eight years as Chairman of the Biology Department at Dalhousie. Don Gordon replaced Richard Addison as acting director for six months until Ken arrived. Martin Blaxland retired as Executive Assistant after serving in the position for fifteen years.



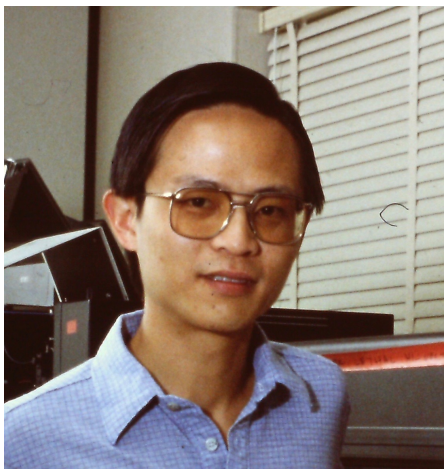
BIO in 1980
Murray and Holland Buildings have been completed and the trailers removed

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

The International Commission of the Northwest Atlantic Fisheries (ICNAF) was disbanded. Its management responsibilities for international fisheries beyond 200 nautical miles were transferred to the newly established Northwest Atlantic Fisheries Organization (NAFO), also headquartered at BIO and headed by Capt. J.C.E. Cardoso.

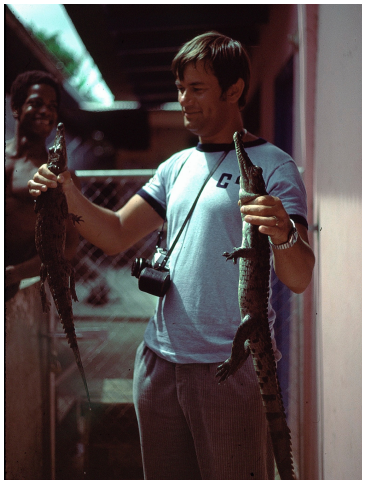
Jacques Cousteau and his vessel *Calypso* visited BIO on way to the Gulf of St. Lawrence and the Great Lakes. He interviewed several MEL scientists and was particularly interested to learn about research underway regarding the potential environmental impacts of tidal power development in the Bay of Fundy. His expedition subsequently resulted in two films produced in partnership with the National Film Board of Canada, one of which included Don Peer.

MEL has a brief hiring spree and new staff included Bill Li, Ed Horne, Erica Head, Peter Cranford and Lorraine Allen. Bill Li had just finished postdoctoral training at the Bigelow Laboratory for Ocean Sciences and the Woods Hole Oceanographic Institution (WHOI) following his PhD at Dalhousie. Ed Horne arrived from a PDF at WHOI and had earlier completed his PhD at Dalhouise. Erica Head earned her PhD at the University College of North Wales and occupied a PDF position at Leeds University before joining MEL. Peter Cranford had just completed his MSc at Dalhousie.



Bill Li

Erica Head



Ed Horne

Peter Cranford

Some program highlights:

- The A.G. Huntsman Foundation was established and based at BIO. This independent foundation established the Huntsman Award, which has since been given annually to mid-career scientists from around the world who have made exceptional contributions to international marine science. This award was named after Archibald Gowanlock Huntsman (1883-1973), the pioneer Canadian oceanographer and fishery biologist who spent most of his distinguished career at St. Andrews, NB. The initial recipients were Henry (Hank) Melson Stommel (US) in physical oceanography, Ramon Margalef (Spain) in biological oceanography and Dan Peter MacKenzie (UK) in geological oceanography. (Vandermeulen, Loncarevic, Elliott).
- 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 research vessel was stopped on station (Herman, Mitchell, Young).
- The bioenergetics describing recruitment as a function of spawning stock biomass were investigated (Ware).
- A dynamic (time-varying) version of the biomass spectrum was developed to allow one to predict the impact of events such as phytoplankton blooms of varying strength on upper trophic levels at some later time (Silvert, Platt).
- A program investigating oil and dispersant toxicology was initiated (Wells, Mackay).

1981

After working as a chemical technician in the Environmental Quality Division for ten years, Jackie Dale moved to the director's office to become the new MEL Executive Assistant, working closely with Ken Mann and Sylvia Smith.

Einar Larsen, Carla Caverhill and Azmeralda Foda joined the staff.

Some program highlights:

- Working with the AOL Metrology Division, the optical plankton counter was developed to replace the electronic plankton counter. It could be mounted on Batfish with other sensors and be towed at speeds up to 10 knots. Plankton tows were no longer limited by space or time (Herman, Platt).
- A marine microbial ecology program was begun using flow cytometry as the principal analytical tool. 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 (Li).
- 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 was conducted in Lancaster Sound (Platt, Conover, Harrison).
- A deep-sea biology program was initiated as part of a BIO-wide program to investigate the feasibility of disposing high-level nuclear waste in deep-sea sediments. 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 to provide the first estimates of feeding rates of deep-sea animals (Hargrave, Kepkay).
- A multiyear study was initiated to investigate the production and export dynamics of salt marshes in the upper reaches of the Bay of Fundy (Gordon, Cranford).
- An international symposium entitled *The Dynamics of Turbid Coastal Environments* (Muddy Waters) was organized and was the first major symposium held in the new BIO auditorium. Recent BIO research in the Bay of Fundy was highlighted and compared to studies done in other turbid coastal environments around the world including the Bristol Channel/Severn Estuary in the UK and the Ems Dollard Estuary in the Netherlands. The proceedings of this symposium were published in a special issue of the Canadian Journal of Fisheries and Aquatic Sciences (Dale, Gordon, Longhurst).
- In collaboration with the Woods Hole Oceanographic Institution, an international conference entitled *Pollution in the North Atlantic Ocean* was held at BIO. The proceedings were also published in a special issue of the Canadian Journal of Fisheries and Aquatic Sciences (Vandermeulen, Farrington).

1982

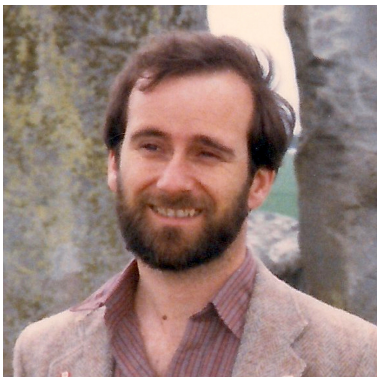
A separate Gulf Region was created in the Department of Fisheries and Oceans (DFO). This resulted in a major reorganization of the research programs at BIO, the Halifax Fisheries Research Laboratory, the St. Andrews Biological Station and the new Gulf Fisheries Centre in Moncton, NB, as well as the resource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

Realizing the need to have a formal mechanism for transferring the results of OSS Atlantic research to clients, including fisheries managers and industry, Alan Longhurst established the Ocean Information Division which was headed by Brian Nicholls.

Derrick Iles became the new head of the Marine Fish Division (MFD). The newly constructed *Needler*, a purpose built fishing trawler, was delivered to BIO to support the expanding MFD programs, especially groundfish surveys.

Assisted by MEL, the Canadian National Committee for the Scientific Committee on Oceanic Research (SCOR) organized the 5th Joint Oceanographic Assembly (JOA) which was held at Dalhousie University. MEL staff participated and BIO facilities were put on display for a large international audience of prominent oceanographers.

New staff included Paul Boudreau and Peter Schwinghamer. Peter had earlier done his PhD at Dalhousie and had been a PDF at MEL before becoming full time.



Paul Boudreau

Peter Schwinghamer

Some program highlights:

- A temperature-controlled incubator, named the photosynthetron, was developed to measure the short time-scale response of phytoplankton photosynthesis to changes in available light. This innovation led to a rapid accumulation of data on the light-dependent parameters of

photosynthesis that became the building block of a great deal of later work (Lewis, Smith).

- MEL took the lead in organizing a major workshop at the University of Moncton to review all the recent government and university research conducted in the Bay of Fundy, review the most recent tidal power development scenarios and offer predictions of likely environmental impacts. The proceedings were published in an influential DFO technical report (Gordon, Dadswell, Keizer, Prouse, Peer, Hargrave, Schwinghamer, Silvert).
- The patterns of intertidal benthic fauna size spectra were examined and it was found that benthic size spectra were not as smooth as pelagic size spectra but showed three modes separated by troughs. These modes characterised macrofauna (too large to live interstitially), meiofauna (too small to burrow) and bacteria (living on the sediment grains themselves). This size spectrum pattern and supporting theory came to be known as the "sediment architecture hypothesis" (Schwinghamer).
- Along with other DFO scientists, MEL participated in a working group examining the impacts of freshwater runoff on the marine environment in Atlantic Canada. All available oceanographic and fisheries data were reviewed (Hargrave, Bugden, Tang, Therriault, Yeats, Sinclair).
- A study of the circulation and tidal currents in the Hudson Straits and their effects on biology was initiated (Drinkwater).

1983

A-Base funding began to dwindle and MEL had to start looking for other sources of funding to support research. One of the first to appear was the national Panel on Energy Research and Development (PERD) under the Department of Environment. It was well supported with federal funds and government labs were invited to apply for funding in support of energy-related research (hydropower, oil and gas, etc.). Proposals were prepared and reviewed by panels made up of government and industry scientists in regard to their merit and relevance to the development of Canadian energy resources. This process also required providing Ottawa with regular progress reports. Other funding sources were identified soon after and became increasingly important with time. These external funding sources to support MEL research came with specific objectives, often quite applied, over which the director had little control.

OSS 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.

New staff included Paul Kepkay who had just completed his PhD at Dalhousie.

Some program highlights:

- Short-term isotope tracer experiments were conducted to investigate the kinetics of nitrate, ammonium and urea uptake and regeneration, forms of nitrogen that limit the growth of phytoplankton (Harrison).
- Experiments were carried out in the Sargasso Sea to determine if iron might be a 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 (Durvasula, Yeats).
- MEL staff participated in the Canadian Expedition to Study the Alpha Ridge (CESAR) in the Arctic Ocean and carried out various chemical and biological studies from an ice island camp established by the Polar Continental Shelf Project (Vass, Prouse, Cranford).
- A new software package called BSIM (Biological Simulation) was developed to facilitate the process of developing modular ecosystem models (Silvert).
- With assistance of numerous European and university colleagues, a project was begun to develop a numerical model to simulate the dynamics of carbon flow in the Cumberland Basin ecosystem using the BSIM modelling software. The work was carried out over three years at a series of workshops with the assistance of others at BIO, local universities and scientists from Germany, the Netherlands and the UK. This was the first such estuarine simulation model developed in North America (Gordon, Silvert, Keizer, Schwinghamer).
- The three-year multidisciplinary Fisheries Ecology Program (FEP) was initiated in collaboration with AOL, MFD and Dalhousie to understand the influence of physical and ecosystem processes on the population dynamics of haddock stocks on Browns Bank. Haddock, a mainstay in the Maritimes fishery, were being heavily overexploited at the time. One of the main findings was that while haddock spawned on Browns Bank off southwest Nova Scotia in the spring, a portion of the eggs and larvae were retained by an oceanographic gyre on the bank while another portion was carried by prevailing currents into the Bay of Fundy. This 'leaky' gyre observation explained the strong size differences between adult Browns Bank and Bay of Fundy haddock within one spawning population. (Dickie, Smith, Campana).
- 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 (Dowd, Shotton).
- The Fisheries Resource Branch established a regional task group to define in general terms the scope of oceanographic research required from OSS to address fisheries issues (Sinclair, Hawkins, Mahon, Marshall, O'Boyle, Uthe, White).

- Using funding from the Unsolicited Proposal Program under DSS, a three-year project was established to investigate mussel genetics in support of the developing shellfish aquaculture industry (Dickie, Freeman, Mallet).

1984

George 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 AOL by Jim Elliott.

During renovations to the Fish Lab, a meeting room was created and named after F. Ronald Hayes, the 'father' of MEL.

Fisheries Oceanography Division

New staff included Ken Frank, who arrived after completing his PhD at McGill, Linda Payzant, Nelson Watson and Jeff Anning. Nelson and Jeff were transferred from the DFO Canada Centre for Inland Waters in Burlington, ON.

Ken Frank

Some program highlights:

- Working with other DFO scientists, MEL staff prepared background oceanographic information that could be used by the Department of External Affairs in building their case for the Gulf of Maine boundary dispute with the US which was being argued before the International Court of Justice in Den Hague. The scientific arguments played an important role in reaching a decision favourable to Canada (Trites, Gordon).
- MEL staff participated in the five-year Canadian Ice Island program which was initiated to conduct oceanographic and geological studies of the ice-covered polar margin between Ellesmere Island and the Beaufort Sea. Working from a permanent ice camp operated by the Polar Continental Shelf Program, chlorinated hydrocarbon contaminants were measured in various environmental compartments such as air, seawater, ice, snow, sediment, and lower trophic level organisms including epontic ice algae, phytoplankton, planktonic and benthic zooplankton, and invertebrates such as amphipods in a permanently ice-covered region of the Arctic Ocean. The ubiquitous presence of these contaminants distant from sources emphasized the global nature of atmospheric transport (Hargrave).
- A study, funded by PERD, of the Grand Banks ecosystem was initiated. Field studies were carried out to collect plankton and benthic information (Platt and Silvert).
- A numerical simulation model of the Grand Banks pelagic ecosystem was developed using the BSIM modelling software package. It used a size-based structure within broad groups to transfer energy from producers to consumers. The work was carried out over several years at a series of workshops involving scientists from other labs. This early simulation model was able to reproduce many of the well-known community dynamics and provide insight into possible environmental impacts of an oil spill at the Hibernia field under development (Silvert, Keizer).
- MEL staff argued and convinced NAFO to resurrect their Environmental Subcommittee. They began to produce annual environmental reports in support of fisheries for the NAFO area that continue to the present (Trites, Drinkwater).

1985

The mid-1980s were ‘golden years’ for MEL. Organizational and policy changes at the Ottawa level had had limited impact on research programs, and resources continued to be reasonable. All components of BIO were thriving and morale was high. By this time in its evolution, BIO had become one of the

major oceanographic institutes around the world and functioned very much like a federal university.

MEL helped organize the annual summer meeting of the American Society of Limnology and Oceanography (ASLO) which was held at St. Mary's University. One evening, OSS hosted a gala lobster banquet at BIO for over 400 delegates which was catered by the Shore Club with unlimited beer and wine plus musical entertainment. The halls in the Holland Building were hopping until the wee hours of the morning! This would never happen today in a federal building.

A gala dinner party was held at the Waegwoltic Club to celebrate the 20th anniversary of MEL. Piano music was provided by Andre Mallet. Alan Longhurst gave some reflective comments and hinted that there might not be many more years left to celebrate.

Some program highlights:

- Under-ice studies of phytoplankton and zooplankton were carried out in Lancaster Sound, NWT (now Nunavut). New equipment was developed for deployment through ice holes to measure currents, the distribution and growth rates of under-ice algae and collect amphipods (Herman, Platt, Conover, Harrison).
- The particle size distributions of the pelagic ecosystems in Hudson Strait and on the Labrador Shelf were studied on a cruise of *Hudson* (Drinkwater, Harding, Sheldon)
- To continue applying an ecosystem approach to fisheries management, the Marine Fish Division organized a workshop to discuss the state of knowledge of the Scotian Shelf ecosystem and consider how best to incorporate this information into fisheries management. Up until this time, little consideration had been given to the broader 'ecological footprint' of fisheries. This workshop was the first of its kind in Atlantic Canada to take this broader ecological perspective (O'Boyle).
- OSS organized the Futures Conference held at the Institute of Ocean Sciences in Sidney, BC, to discuss research and survey programs for the coming decade. The discussion included the scope of oceanographic research required from OSS to address the fisheries issues being tackled by the Fisheries Resource Branch (Mann, Boltin, Sinclair).
- The DFO Atlantic Directors Committee formed a working group to determine the fisheries research needs for physical oceanographic information. A final report was released in 1987 (Sinclair, Loder, Gascon, Horne, Perry, Sandeman).

1986

This year marked the beginning of a major DFO reorganization that had a huge impact on MEL. Full details are provided in the next section.

DFO released a new national fish habitat policy which called for a closer working relationship between departmental habitat managers and scientists in all regions across the country. It introduced a long-term policy objective of overall 'Net Gain' and an ambitious guiding principle of 'No Net Loss' of the productive capacity of fish habitats, both freshwater and marine. The policy also set forth goals of fish habitat conservation, restoration and development.

Some program highlights:

- Long term monitoring studies with ringed seals at Holman (now Ulukhaktok), NWT, and grey seals on Sable Island demonstrated that declines in total DDT-group concentrations in both male and females were greater on Sable Island. A possible explanation for this unexpected difference was that much of the DDT-group degradation actually occurs in the food web upon which the seals feed. This process would be expected to be faster around Sable Island because environmental temperatures are higher throughout the year (Addison).

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. This reduced the scope of BIO research programs in the Gulf.

This was a year of huge changes, disruption and marked the end of MEL as an organizational entity. A substantial number of staff were declared surplus, some transferred to the Newfoundland Region while most remained at BIO and were distributed throughout the new organization according to their scientific discipline. Full details are provided in the next section.

Some program highlights:

- Experimental measurements in Jones Sound and Baffin Bay indicated that summer communities of ciliated protists had the potential to consume up to one half of the primary production on a daily basis. The transfer of energy and the recycling of nutrients by this microbial community were evidently no less at high latitudes than at lower latitudes (Paranjape).
- Size-dependent processes underlying regularities in ecosystem structure were investigated (Kerr, Dickie, Boudreau).

- A scientific evaluation of the likely environmental impacts of exploratory drilling on the Georges Bank ecosystem was completed for the Gulf of Maine Advisory Committee (Gordon, Trites).
- 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 (Durvasula).

LAST DAYS

1985

During 1985 it became clear that a major national reorganization of the Department of Fisheries and Oceans (DFO) was being considered in Ottawa. At the request of Gerry Ewing, the ADM of OSS, Alan Longhurst prepared a for-instance science policy document for DFO entitled *Science at Sea: the Science Policy and Program of the Department of Fisheries and Oceans.* In it he attempted to put fisheries responsibilities in balance with other important ocean issues such as energy, climate and sovereignty. This document provided information from a BIO perspective that Gerry Ewing could use in departmental discussions at the national level.

Not long after, BIO began to receive numerous visits from people in the Treasury Board and the upper echelons of DFO. Ken Mann, the director of MEL, was interviewed about the process of scientific research and the role of MEL. The concept of the federal government supporting a world-class oceanographic institute focused on long-term research seemed to cut little ice. It was clear they saw that our primary role should be to provide scientific advice to fisheries and habitat managers. Ken responded that MEL did in fact devote considerable effort to investigating practical problems and to giving advice in an ecological context. He gave numerous examples of recent research, including evaluating the environmental impacts of chlorinated hydrocarbons, oil spills, potential tidal power development in the Bay of Fundy and the growing offshore oil and gas industry. He also emphasized that the best scientific advice came from scientists actively involved in cutting-edge research. While discussing research planning, he explained that new projects were selected by the research scientists themselves to address the most serious gaps in understanding the functioning of marine ecosystems underlying fisheries.

The Ottawa mandarins expressed a completely different view. They felt that the government must first determine the fields of study that would be of most benefit to Canadians and then scientists could plan a program of research to meet these needs with milestones of achievement against which progress could be measured. Ken argued that senior managers are not the best people to decide what will be a fruitful line of research, only the scientists can do this.

These arguments were all in vain and it soon became clear which direction the wind was blowing.

1986

In early 1986, major top-down changes in the national organization of DFO began. These changes had a profound impact on all laboratories across the country, not just MEL. Tom Siddon was the new Minister of DFO (1985-1990) under the Mulroney Government. Art May, originally a fisheries biologist from Newfoundland, was replaced as Deputy Minister by Peter Meyboom in February 1986. Meyboom was a geologist in training but later had become a career bureaucrat. He had earlier worked for the Treasury Board and during this posting had developed the proposed policy document for the new Department of Environment referred to earlier (Meyboom 1972). He was a long-time proponent of the planning, programming and budgeting (PPB) process for running government programs. Art May was the last deputy minister to come up from the regions who had direct experience with DFO fishery research programs. After being replaced by Meyboom, he stayed in Ottawa and became the President of the Natural Sciences and Engineering Research Council (NSERC).

Within a few weeks of taking over as Deputy Minister, Peter Meyboom called Alan Longhurst (Scotia-Fundy Region), Ced Mann (Pacific Region), Jean Puize (Quebec Region) and Gerry Ewing (Headquarters), the senior Ocean Science and Surveys (OSS) managers across the country, to Ottawa. He met with them individually and announced that OSS was being disbanded, their managerial positions were being declared surplus and all OSS staff and programs were to be incorporated into the Fisheries Resource Branch. All DFO science programs were to be integrated under a new ADM of Science based in Ottawa. They were stunned at this unexpected announcement, a major and far-reaching decision made at the highest levels of DFO in Ottawa without any discussion with OSS managers. At the same time, some managerial positions in FISHERIES RESOURCE BRANCH were also declared redundant.

Upon returning to BIO, Alan called an open meeting with all OSS staff in the auditorium to report the Ottawa decisions and declared his ignorance about what would happen next. These decisions impacted not only MEL but also all components of OSS and FISHERIES RESOURCE BRANCH at BIO including the Atlantic Oceanographic Laboratory (AOL), the Canadian Hydrographic Service (CHS) and the Marine Fish Division (MFD).

Peter Meyboom initially offered the new Science ADM position to Alan but, since he felt strongly that the decisions being made were a bad mistake, he declined it. Since it was too early for Alan to retire, Meyboom agreed he could go back to the bench as a research scientist in the Biological Oceanography

Division at BIO, but under the condition that "*he kept his mouth shut*" about these organizational changes. However, soon after, Alan did draft a series of notes entitled *DFO Science Integration: the View from BIO* which were passed up the line. They outlined some concerns that he felt must be addressed in planning the science integration.

The reason given for terminating OSS was that DFO fisheries Directors-General had complained that they were not getting the information from OSS that they needed to help manage the fisheries for which they were responsible. Peter Meyboom had asked Tim Parsons at UBC (formerly a Fisheries Research Board scientist at the Pacific Biological Station in Nanaimo, BC) for advice on how to solve this problem, and he recommended merging OSS with the Fisheries Resource Branch.

It should be noted that there had been some history of discord between OSS and the Fisheries Resource Branch in recent years, which was not surprising since the two branches of DFO had quite different objectives and mindsets. OSS was focused on multidisciplinary long-term oceanographic research while the Fisheries Resource Branch was focused primarily on short-term applied research dealing with the management of commercial fisheries. This discord was recognized by the Fisheries and Oceans Research Advisory Council who stated in their 1983/84 Annual Report that it was essential that a more satisfactory relationship be established between fisheries and oceanography in the department.

The reason provided for taking this drastic action was actually quite poorly founded. OSS had always recognized its responsibility to provide oceanographic information for fisheries management and was always open to requests for advice. For example, soon after Alan Longhurst arrived as the new MEL director in 1977, he went to see Barry Muir, Director of the Fisheries Resource Branch in Halifax, to discuss potential research cooperation. Having previously worked for the West African Fisheries Research Institute, the New Zealand Department of Fisheries and the US Southwest Fisheries Science Center, he fully appreciated the importance of ecosystem information in managing commercial fisheries. However, Barry Muir told him that FRB did not require any assistance from MEL and that they would do what was required themselves.

Soon after, in 1978, the Fisheries Resource Branch established the Canadian Atlantic Fisheries Advisory Committee (CAFSAC) to formulate scientific advice on fish stocks for fisheries managers. This was a dynamic group with a broad range of research interests. On behalf of OSS, the MEL director became a member, participated in the monthly meetings and was always willing to contribute to deliberations as needed.

Despite these efforts taken by OSS, a few years later DFO fisheries management directors started to complain to their ADM that they were not getting the information and cooperation they needed from OSS. This dissatisfaction was conveyed to the ADM of OSS, Gerry Ewing, who in turn asked all OSS regions to do what they could to remedy this complaint. By this time, Alan Longhurst was the Regional Director-General of OSS Atlantic and responded in 1980 by diverting resources to establish a BIO Marine Advisory and Industrial Liaison Office (BIOMAIL) to serve as a point of entry for all potential clients, including fisheries managers, seeking information and advice from OSS Atlantic. BIOMAIL was initially headed by John Brooke and facilitated the transfer of oceanographic technology and promoted close relations between ocean industries and BIO. Although plenty of useful relations were established with the expanding offshore oil and gas and other industries, no specific needs were ever defined by fisheries managers through this portal.

A few years later in 1983, Alan Longhurst approached Jim Stewart, now director of the Fisheries Resource Branch after Barry Muir departed for Ottawa, asking him to specifically define what oceanographic information they required from OSS for fisheries management. This time his request was positively received. Jim had a broad scientific background and appreciated the importance of understanding the role of environmental factors in fisheries management. In response, he set up a working group of regional fisheries scientists, chaired by Mike Sinclair, to define their needs for physical and biological oceanographic information (Sinclair et al. 1986). One of the conclusions of this review was that a tight linkage between oceanographic and fisheries research was not needed and that physical oceanographers should plan their research to lead to significant discoveries in their own disciplines. However, in doing so they should address the large spatial (100s of km) and temporal (decadal) scales of importance to fisheries. With regard to the requirements of habitat management, it was recommended that biological oceanographic research should continue to focus on ecosystem structure and function.

To carry this initiative further, in 1985 the DFO Atlantic Directors Committee established a second working group to determine the fisheries research requirements for physical oceanographic information. This working group, again chaired by Mike Sinclair, was composed of scientists from both OSS and FISHERIES RESOURCE BRANCH (Sinclair et al. 1987). The importance of analyzing and publishing existing physical oceanographic data sets in areas of importance to Atlantic Canada fisheries was emphasized, also the importance of long-term oceanographic monitoring programs to define inter-annual variability and trends in ocean characteristics. It was also recommended that each DFO region create permanent working groups to facilitate the linkages between physical oceanographers and fisheries biologists.

Clearly, the door to OSS had always been open to provide advice and information in support of fisheries management, as it also had been for habitat management. As reviewed above, various mechanisms had been set up to facilitate this process and encourage collaboration between OSS and FISHERIES RESOURCE BRANCH. It would appear that the senior managers in Ottawa, mostly with a background in fisheries, were either not aware of these initiatives or deliberately chose to ignore them. Nevertheless, it was too late in the day to reverse the action taken. The decision to disband OSS, including MEL, and merge it with FISHERIES RESOURCE BRANCH was final. Many felt that this was the outcome desired by the senior fisheries managers in DFO from the very beginning.

Scott Parsons, previously a fisheries scientist in the Newfoundland Region, was then appointed as the new ADM of Science in Ottawa. Soon after taking the position, he announced the steps that would be taken for integrating Ocean Science and Surveys (OSS) and the Fisheries Resource Branch into the new DFO Science organization, namely:

- New organizational structure
- Unified administration of ships and facilities
- New mechanisms for interaction with clients
- Clarified mandate for oceanography with a clearer link to DFO responsibilities
- Clarified interface between DFO Science and other departments, universities and provinces
- Integrated program review, work planning and financial reporting.

He also announced a number of studies to collect background information and develop options for the new organizational structure. These included:

- Review of fisheries science in Pacific and Freshwater Zones to complement the review of Atlantic fisheries research nearing completion
- Review of physical and chemical oceanography in DFO
- Review of the Marine Ecology Laboratory and biological oceanography in DFO
- Inventory of programs in CHS
- Review of vessel needs of Science and opportunities for consolidation
- Analysis of precedents, pros and cons of establishing a legislative mandate for DFO Science
- Study of means to increase the visibility and profile of DFO Science and the credibility of scientific advice to Fisheries Management.

The review of the Marine Ecology Laboratory and biological oceanography was subsequently carried out by a team composed of John Loch (Gulf Region, Chair), Mike Bewers (Atlantic Oceanographic Laboratory, BIO) and Frank Bernard (Pacific Biological Station, Nanaimo). All three had backgrounds in science. Fourteen science units from the former Ocean Science and Surveys

(OSS) and current Fisheries Research Branch were considered to be in the purview of the review. The review team met with science program managers across the country and posed a set of basic questions about research activities. They also consulted with 150 clients of DFO research including DFO fisheries managers, DOE, DIAND, EMR, provincial and territorial fisheries and environmental agencies, the energy and fishing industries, native groups, universities, consultants and international agencies. In April, the study team visited BIO and interviewed Ken Mann, the MEL director, and Trevor Platt, Barry Hargrave and Don Gordon, the MEL division heads at that time. Written material was prepared and submitted.

The results of this review were presented in an internal report (DFO 1986). The following major points were made:

- There was considerable demand from Newfoundland clients for the North Atlantic Fishery Centre to have an increased physical oceanographic capability. Other un-serviced regions (Gulf, Western) were also expected to have some on-site physical oceanographic capability.
- Environmental concerns on the Grand Banks (Hibernia), in the Gulf of St. Lawrence (toxic contaminants) and the Arctic (Beaufort Sea) led to expectations for some chemical oceanographic capability in the Newfoundland, Gulf and Western regions.
- Considerable demand was expressed, not just by clients external to DFO but also by DFO resource managers, for targeted basic research on toxic chemicals and other contaminants (sources, transport, fate and effects) and in follow-up habitat assessment activities.
- Virtually all clients expressed strong support for the primary and secondary production research undertaken by MEL. However, it was noted that there seemed to be little explicit demand for this research outside the university and international scientific communities.
- Fisheries clients expressed strong concern over the current state of stock assessment methodology. Major improvements are needed in accuracy and more methodological research was needed.
- There was concern about the lack of physical oceanographic input into the siting of aquaculture projects and poor understanding of environmental effects. Some clients called for more direct regional support of fish health diagnostics (Newfoundland, Gulf).
- There was concern about the limited knowledge of species interactions, recruitment and environmental influences on the ecological relationships of major fisheries.
- The current proportion of effort in the Atlantic Fisheries Research Branches devoted to stock assessment compared to fisheries ecology was questioned as being too high on the assessment side.
- Fisheries clients expressed concerns about predation on commercial stocks by seals and the effects of seal (cod) worm on product quality.

More work was needed on marine mammals in terms of stock assessment, ecology and predation.

- DIAND, DOE, COGLA and the energy industry felt that DFO did not accord the same attention to them as fisheries clients and expressed concern regarding the priority assigned to environmentally related research in DFO.
- Environmental clients indicated that DFO was inflexible in its research planning and issues that arose quickly usually could not be dealt with in a suitable time frame.
- Environmental clients were concerned that DFO frequently appeared before public hearings expressing concern over an industrial development because knowledge was insufficient, but did not demonstrate a willingness to conduct appropriate research.
- Some concern was expressed about the neutrality of DFO scientists. Environmental clients felt that the role of DFO scientists should be to present facts, not reflect departmental policy.
- Makivik Corporation pointed out that northern clients had recently called for a new Arctic region within DFO.
- Pacific DFO managers supported the maintenance of long-term biological databases.
- The point was made that MEL was a major force internationally and it was untenable that DFO consider eliminating MEL while the Arctic Biological Station remained open.
- While matrix management was not generally liked, it was felt the most viable approach to the management of most targeted basic research in Atlantic and Arctic science.
- Many managers pointed out that if matrix management was adopted, it would be essential that all regions have sufficient leverage to ensure equitable access to resources.
- Several DFO Science representatives felt MEL needed to become much more directly involved in resource assessment issues.

Analysis of these client demands and current program capability led to the following major findings:

- Primary and secondary production – 40% of biological oceanography was spent on primary and secondary production. There were five laboratories working on targeted basic research with relatively small client demand. It was likely that a more focussed effort would yield greater benefits.
- Fisheries ecology – 48% of biological oceanography (76 PY) was devoted to this subject and it involved six science units. Given the high client demand and current level of dissatisfaction, improved focus and increased resources were necessary.
- Research on sources, transport and fate of contaminants and biological effects thereof – Efforts were devoted to these subjects in seven of the eight units considered in the review. This investment was adequate but

overly fragmented. Given the substantial capital costs and the generic nature of this research, some economies might be achieved through amalgamation.

- Marine mammals and parasitology – Clients were concerned about seals and parasites in Atlantic Canada and demanded more effort. The current level and dispersion of effort for both mammals and parasites among five of eight units involved warranted scrutiny.

The general conclusions drawn from this review were:

- Client demand existed for both targeted and applied research. An equal level of effort should be accorded to both. DFO operational managers and the fishing industry alike identified the need for targeted basic research, especially on fisheries ecology and stock assessment methodology.
- There were inequalities in the regional capability to meet client demand. There were imbalances within the Atlantic zone because the new Institut Maurice-Lamontagne (IML) would have larger capability than Gulf and Newfoundland Regions combined. In the Pacific, the weakness of ocean ecology in the Institute of Ocean Sciences compared to the Pacific Biological Station, IML or MEL was marked. Lack of expertise in the Western Region on arctic marine ecology contrasted strikingly with that of MEL and IML. Within biological oceanography, the current proportion of PYs among Atlantic, Arctic and Pacific was about 65:25:10 respectively. Clearly, Pacific was relatively under-resourced.
- Fisheries, environmental and ocean climate clients were the major users of the results of biological oceanographic research. There were significant interregional differences in the nature of client demand. Western and the Arctic Biological Stations had predominantly environmental clients whereas other labs principally serviced fisheries demands. The former OSS research units had a predominance of environmental and ocean climate clientele.
- Deployment of Science PYs among the various major fields of scientific endeavour allocated approximately 6% to biological oceanography. Several clients, including Fisheries Management, expressed concern over this relatively small resource base compared to that devoted to resource assessment and other disciplines.

During this review, considerable support was expressed for MEL and the ecological research it had been carrying out. However, there was no strong recommendation regarding its fate, either positive or negative. It is not clear how widely this document, stamped CONFIDENTIAL, was circulated and the influence it had on subsequent decisions. Presumably it was seen by Scott Parsons and other senior managers in Ottawa, but it was never circulated to regional division heads and scientific staff.

During this review it became evident that MEL was somewhat of an anomaly in DFO. It was the only previous Fisheries Research Board lab that did not join the Fisheries Resource Branch in 1975 but elected instead to become part of OAS (precursor to OSS). Its research program was focused on understanding the structure and function of ecosystems supporting fisheries and not on more applied single species fisheries management issues. Because of the desire of Ottawa to establish the same organizational structure in all regions across the country, it was clearly particularly vulnerable.

In April, Barry Muir from the Fisheries Resource Branch in Ottawa was appointed as acting Regional Director of Science for the Scotia-Fundy Region and moved back to BIO for a year. He was charged with setting up the new science organization in the region. He was fully aware of how upset BIO was with the disbanding of OSS and merger with FISHERIES RESOURCE BRANCH. With his past history as a research scientist and acting director at MEL he must have realized from the outset that this would be a stressful posting. As previously agreed with Meyboom, Alan Longhurst vacated his office on the fourth floor and moved down to the Strickland Building to resume a productive career as a research scientist in the Biological Oceanography Division. At the same time, the St. Andrews Biological Station and Halifax Fisheries Research Laboratory lost their status as independent laboratories and all regional science programs now reported directly to Barry Muir at BIO.

This new Regional Director of Science position now reported directly to the Regional Director-General in Halifax, not to an ADM in Ottawa. This marked the end of direct reporting by BIO oceanography programs to Ottawa, as had been the practice since BIO was founded 24 years ago. As result of this change, there was regrettably no longer a strong voice for oceanography in the nation's capital where most of the DFO senior science managers now in control had a fisheries background.

Soon after, Peter Meyboom announced the new policy priorities of DFO. These were defined to shape the new direction the department would take in carrying out its ongoing mandate to manage fisheries resources with greater emphasis on conservation and enforcement, and on improving the consultative and regulatory process. They also addressed the need to consolidate DFO Science activities and ensure they respond more closely to the needs of clients. Oceanography was not explicitly recognized as a priority.

In June, Alan Longhurst drafted a confidential paper entitled *DFO Science Integration: Rejoiners, Axioms and Dubious Propositions* which was sent up the line to Gerry Ewing and presumably passed on to Scott Parsons. It contained some detailed comments of the claims of the fisheries RDGs concerning the lack of appropriate support they had received previously from OSS as well as an exhaustive analysis of the relationship between fisheries science and oceanography in the thirty-four member countries of the Scientific

Committee on Ocean Research (SCOR). Alan later felt that all his recommendations were totally rejected and that if he had accepted the Science ADM job he would have been fired within six months. He clearly was on a politically unacceptable wavelength.

In July, in a memo to all DFO employees, Peter Meyboom announced that the current four DFO ocean science regions and seven fisheries management regions across the country were to be consolidated into six regions (Newfoundland, Scotia-Fundy, Gulf, Quebec, Central and Arctic and Pacific). Each region was to be organized following the same template with three streams of activity reporting to a regional director-general:

- Fisheries and habitat management
- Science
- Support services

He also announced the appointments of senior DFO managers in all six regions across the country. In the Scotia-Fundy Region, J.-E. Haché was appointed as Regional Director-General and Neil Bellefontaine was appointed as Regional Director of Fisheries Operations.

Also in July, a review of DFO Atlantic fisheries research prepared by Bill Doubleday, Director of Policy & Program Coordination Branch in Ottawa, was released. It examined the status of MEL as a separate branch in the new Scotia-Fundy region and noted that it was unique. It then recommended that MEL staff should be reassigned to the corresponding divisions in AOL and the Fisheries Resource Branch, effectively marking the end of MEL as an organizational entity. It was argued that this action would reduce management overhead in the region and be consistent with departmental organization in other regions and Ottawa. It is not certain if this report was ever circulated around BIO.

On 24 September, three major announcements regarding DFO resource cuts and reorganization were made. The first of these was a press release from Tom Siddon in which he announced a series of initiatives including:

- Staff reductions required by the May 1985 budget and reallocations to meet priorities
- An integrated science program which would be better focused and more relevant to the needs of industry
- Administrative improvements to regional operations.

He also stated that, as announced in February, the DFO fisheries research and oceans science programs were being consolidated. Here are some quotes from Siddon:

"The science organizational and resources changes will unify and strengthen the Department's science effort. This will ensure that scientific efforts better

support the Department's mandate and that the world-class quality of DFO's science program is maintained."

"These changes will allow the Department to reallocate resources to issues of high priority. For example, we will now be able to devote more resources to improve our understanding of fish migratory patterns. This information will be of very practical use to the fishing industry and to resource managers."

"Some resources are being redirected to establish a new science component in St. John's, Newfoundland and expand the Gulf Region's science effort. Scotia-Fundy will retain the Department's largest science program."

He also announced that National Centres of Disciplinary Expertise (CODEs) would be created across the country within existing departmental establishments to ensure that work on critical research issues would be focused. The proposed CODEs and their locations were:

- Atlantic Resource Assessment and Survey Methodology (NAFC)
- Biological oceanography (BIO)
- Marine contaminants and toxicology (BIO
- Parasitology (IML)
- Freshwater fisheries contaminants (Freshwater Institute and Bayfield Lab)
- Genetics and biotechnology for aquaculture (PBS and West Vancouver Lab)
- Ocean climate and chemistry research (IOS)

Appended to this Ministerial press release was a summary of initiatives and tables showing expected staff changes in DFO. In final quote, Siddon stated:

"I announced a new international fisheries policy in June 1986. In that policy is a commitment to protect Canada's fisheries resources. Through increasing resources for surveillance and enforcement, I am meeting that commitment. The other priority areas all reflect my commitment to fulfilling my mandate based on the needs of the industries we serve."

On the same day, in a memo to all DFO employees, Peter Meyboom provided an update on the approved organizational changes which would allow DFO to meet its many challenges. Much of the information was repeated from Siddon's simultaneous press release. He announced the details of extensive cuts in expenditures and PYs. DFO must reduce its total person-year (PY) complement by 579 over several years. He reported that the RDGs had developed a plan to reduce regional staff by 312 PYs for FY1987-88. Of these, 89 PY were to be reallocated to areas considered high priority by fisheries and oceans industries so that the net reduction would be 223 PY or 4% of the total DFO workforce. These high priority areas to be augmented were:

- Surveillance and enforcement

- Salmonid Enhancement Program
- Habitat management
- Acid rain research
- Management information systems
- Inspection program

Oceanography and fisheries research were not included in these priorities. For the first time, it was stated that there might be some requirements for the relocation of personnel to address these new priorities. Support and administrative services were to be consolidated and it was expected that most of the required staff reductions to meet assigned targets would occur here. It was stated that every effort would be made to minimize hardship on employees whose positions will be declared surplus and to facilitate their redeployment to other positions in the Public Service.

In addition, he announced that the integration of DFO science programs just announced by the Minister brought together the various programs in each region under individual regional directors of Science. The three organizational units in each region would be the Biological Sciences Branch (BSB), the Physical and Chemical Sciences Branch (PCSB) and the Canadian Hydrographic Service (CHS). BSB would include both fisheries and biological oceanographic research science, while contaminant and toxicological research would be integrated into PCSB. It was also stated that research units would operate on the matrix principle which would enable multi-disciplinary teams to be deployed to work on key issues and that these changes would enable DFO to reallocate resources to issues of high priority. These decisions were made at the top without any input from the working level.

Also on 24 September, Barry Muir announced his plans for the realignment of all existing DFO scientific staff in the Scotia-Fundy Region which included those at BIO, the Halifax Fisheries Research Laboratory and the St. Andrews Biological Station. This plan was consistent with the instructions he had received from above for all regions in the country. In his memo to staff, he stated that he believed this new structure would improve coherence, strengthen interactions, continue to foster high quality research and enhance the viability of its significance to government priorities. He recognized that these changes would affect many people and how we would interact in the future.

His memo included charts of the new organizational structure showing the proposed divisions, directors, division heads and the assignment of MEL staff. There were no appreciable changes in Hydrography and Adam Kerr would continue as director. All four divisions of the former Atlantic Oceanography Laboratory (AOL) were retained as is under the new Physical and Chemical Sciences Branch (PCSB) to be directed by Jim Elliott. These divisions were Coastal Oceanography (Clive Mason), Ocean Circulation (Alynn Clarke), Marine Chemistry (Mike Bewers) and Metrology (Dave McKeown). All four

divisions under the former Fisheries Research Branch were also retained as is under the new Biological Sciences Branch (BSB) to be directed by Jim Stewart based in the Hollis Building in Halifax. These divisions were Marine Fish (Don Bowen), Invertebrates and Marine Plants (Mike Sinclair), Freshwater and Anadromous (Neil MacEachern) and Fisheries and Environmental Sciences (Bob Cook). MEL disappeared completely from the new organizational structure and was slated to disappear on 1 April 1987. However, its Biological Oceanography Division, earlier identified as a national CODE, was retained as a separate entity under the BSB. Unfortunately, the Environmental Quality and Fisheries Oceanography divisions were dismantled and, without any consultation, the thirty-five staff were reassigned to other divisions in both PCSB and BSB on the basis of their primary discipline. Most went to the Marine Fish, Invertebrates and Marine Plants, Coastal Oceanography or Marine Chemistry divisions. As could be expected, these decisions breaking up well established research teams of international stature were not well received by the affected staff.

Barry Muir stated that this plan for the new divisional structure was close to final but still open for discussion and slight revision if necessary. He indicated that at this time no physical movement of staff in Dartmouth, Halifax and St. Andrews was being contemplated.

Another major change announced at this time by Ottawa that affected all DFO regions was the introduction of 'sector management' to replace the traditional practice of 'line management'. This move generated much heated debate for it marked a radical shift in how government operated. Current science-trained line managers were very much in opposition when it was first proposed and felt it was a major step backward. Up to then, under line management, all the different administrative and technical groups supporting the science programs at BIO reported to the Regional Director-General of OSS. These included ships, buildings, computers, libraries, purchasing, finance and personnel. Therefore, executive decisions affecting these groups were made with a full understanding and appreciation of the requirements of the science community. However, under the new sector management model, all non-science functions were moved to separate branches that reported directly to senior managers in Ottawa, in essence building new silos. Therefore, the new Regional Science Director at BIO would have no executive control over the non-science sectors. Subsequently, the Management Services Branch and the Comptroller's Branch were created at BIO. Following this new policy further, in 1995 the operation of BIO research vessels was transferred to the Canadian Coast Guard and, in 2000, the responsibility for looking after the BIO buildings and grounds was transferred to the Department of Public Works and Government Services.

All of these new non-science managers became members of the Tuesday Club and therefore had considerable influence on how the BIO campus was managed. As well as placing essential scientific support functions and their

resources under the control of career managers not trained in science, these moves increased the overall bureaucracy and administrative burden and led to reduced flexibility in the director's office. These changes further illustrated the growing trend of increasing top-down management and control from Ottawa.

This bombardment of simultaneous announcements stunned MEL staff and it took a while for the implications sink in. Barry Muir held an information session for MEL staff a few days later to provide further explanation of the Science reorganization. At that time, he confirmed that a considerable number of MEL staff could be asked to transfer to the Newfoundland Region, perhaps as many as one third. This was further grim news and staff morale plunged even lower. For the first time, many felt that perhaps the time had come to start looking for jobs elsewhere.

This new organizational structure left the Biological Oceanography Division unscathed and therefore their staff were not motivated to question the decisions. However, staff in the Environmental Quality and Fisheries Oceanography divisions, slated to disappear, were naturally quite upset. Several memos proposing alternative divisional structures were prepared and sent to Barry Muir but to no avail. However, on the basis of feedback, in early October he did announce a few adjustments in the assignment of MEL staff to the new divisional structure.

In October, Jim Stewart, now director of the Biological Sciences Branch (BSB), created two committees to assist in the organization of the new BSB as outlined by Barry Muir. A Mandate Committee, chaired by Ralph Halliday, was tasked with preparing a concise description of the branch mandate and scientific opportunities while an Organization Committee, chaired by Barry Hargrave, was tasked to prepare different alternative organizational scenarios for consideration that could deliver the proposed mandate. Both committees were composed of scientists selected from the five proposed BSB divisions. This was the first time that MEL staff were asked by management to participate in the reorganization exercise and have some input into the decisions being made. Jim Stewart then proceeded to prepare a plan on how BSB would absorb the scheduled PY cuts from 341.7 to 250.2 by 1 April 1988, a reduction of 27%.

By this time, OSS staff at BIO, especially in MEL, had become very frustrated about what was taking place and concerned about the future of oceanographic research, which seemed to be seriously threatened. Dissatisfaction was widespread and morale was at an all time low. Work almost ground to halt because much time was spent in meetings discussing the implications of these recent events. It was clear that substantial cuts in financial and PY resources were coming, OSS had already been disbanded as an organizational entity and MEL was due to disappear at the end of the fiscal year.

As a result, a number of MEL staff became activists and began to make sure that word of what was happening got out to university colleagues, other oceanographic institutes and the media. Eric Mills in the Department of Oceanography at Dalhousie played a leading role in spreading the word and raising concerns. He urged his university colleagues to take political action. Others at Dalhousie assisting Eric in these efforts included Sifford Pearre and Peter Wangersky. Letters protesting the federal science resource cuts and the disbanding of MEL were written to Tim Siddon and key MPs including Mike Forrestall, Stewart McInnes, Howard Crosby and David Orlikow (NDP science critic). In addition, thirteen Dalhousie marine scientists sent a petition protesting the closure of MEL to Tom Siddon. As a result of these protests, these issues were raised during question period in the House of Commons by opposition MPs. Letters of protest were also sent to provincial MLAs including Joel Matheson, Terry Donahoe and Bob Levy and the issues were discussed in the provincial House of Assembly. However, in both cases, no positions or actions were taken. These protests were quickly picked up in the media and a series of articles appeared in the Chronicle Herald and Mail Star during September and October.

In early October, Eric Mills summarized the concerns of the broader scientific community in a letter to Canadian Research (Mills 1986). DFO had announced that MEL would be disbanded. Effective 1 April, its scientists would be reassigned to more narrow groups dealing with fisheries, applied environmental problems and physical oceanography. Despite claims by departmental spokesmen that the reorganization would broaden the interaction of its scientists and that environmental crises could be met by putting together teams, Canadian marine science had returned to the state it was in before 1965, with one major exception. Basic oceanographic science had been hit hard and brought firmly under the control of fisheries administrators within DFO. A power struggle had ended leaving oceanography the poorer and the implications were great. He posed four questions for Siddon to answer:

- How will reorganization actually promote basic science?
- Why was it done in secrecy?
- Why was it necessary to demote highly respected scientist administrators?
- Why have scientists been gagged?

He went on to say that the DFO reorganization betrayed the vacuum at the heart of Canadian science policy. When some of Canada's best marine scientists became the pawns of short-sighted, secretly conceived government plans, both the public and the scientific community were being ill served. He stated the opinion that the pending closure of MEL represented a significant step backward for Canadian oceanography.

As expected, the letters of protest to Siddon and DFO senior managers were not well received. In one newspaper article, a defensive Peter Meyboom was quoted as saying that the BIO staff cuts were only speculation and that the university protesters didn't know what they were talking about.

In the background of these protests regarding the reorganization of DFO Science, a much larger national science policy issue was developing and reported in a series of articles in the Globe and Mail. Frank Oberle, the federal Minister of State for Science and Technology, was preparing far-reaching science policy guidelines for submission to Cabinet that threatened to eliminate thousands of research jobs in at least four federal departments and to hand over most research to the private sector. He made it clear that he believed basic research should be eliminated from federal laboratories and would prefer that government funding be funnelled toward projects that could be done in the private sector. In addition, it was announced that there would be further cuts to the National Research Council (NRC) and university research. The Professional Institute of the Public Service of Canada (PIPS) joined the action and urged all Canadians to contact the Prime Minister to protest the planned cutbacks in funding. Letters of protest were also written by several universities. The point was made that Ottawa's cuts were putting basic research in Canada in jeopardy and that budget slashing must stop. This was indeed a critical time for all government and university research across the country and unfortunately there was not a strong defensive voice for science around the table in the Mulroney Cabinet.

In late October, the final report of the BSB Mandate Committee chaired by Ralph Halliday was submitted to Jim Stewart. Soon after, the final report of the BSB Organization Committee chaired by Barry Hargrave was submitted as well. It proposed three possible scenarios for consideration with the pros and cons of each as well as possible variations. The first proposed three divisions based on function:

- Marine community production (52 PYs)
- Fisheries management research (113 PYs)
- Aquaculture and enhancement (106 PYs)

The second scenario proposed four divisions based on geographic location:

- St. Andrews (69 PYs)
- Lower Water Street (53 PYs)
- BIO (76 PYs)
- Hollis Building (73 PYs)

The third proposed five divisions based on taxonomic classification:

- Biological oceanography (24 PYs)
- Invertebrates and Marine Plants (69 PYs)
- Marine fish (82 PY)
- Freshwater and Anadromous (76 PYs)

- Aquaculture (43 PY)

Jim thanked the committee for the excellent report and circulated it to division heads for review. He asked them to pass the report on to all staff for discussion and to prepare recommendations on which structure to adopt. The majority of division heads favoured the third scenario based on taxonomy which was ultimately adopted.

On 3 November, Jim Stewart sent a memo to Barry Muir outlining the priorities for BSB in 1987-88 which were developed in consultation with Fisheries and Habitat Management Branch. They were:

- Seal worm
- Aquaculture
- Recruitment
- Georges Bank
- Stock identity
- Halibut
- Ground fish stocks in the Gulf of Maine area
- Informatics
- Fisheries ecology
- Benthic productivity cycles
- Climate research

Most of these priorities addressed fisheries issues but some did address ecological aspects. Jim also emphasized the difficulties faced by absorbing the schedule cuts. Of the 341.7 PYs in Fisheries Resource Branch and MEL, 99.5 PYs were being lost due to transfers or layoffs. This loss of almost 30% of the staff would impose considerable strain and work in setting up and maintaining new relationships. It would also be difficult to carry out even core programs.

Presumably anticipating possible actions concerning the breakup of MEL, relations with the media were discussed by senior regional DFO managers. On 20 November, the Regional Director General J.-E. Haché issued an extensive list of guidelines for dealing with the media to all DFO staff. As a general rule, communications should be handled at the director's level. These guidelines included the following:

- The role of each DFO employee is to provide factual information within his/her area of responsibility and competence.
- DFO employees should not speculate on future policies, programs, activities of direction of DFO.
- The personal opinions of DFO employees relating to DFO policies, programs and activities, which differ from the official DFO line, should not be discussed either publicly or with the media.
- DFO employees should avoid publicly criticizing the Department and should also avoid comments which do not put DFO in a positive light.

- Media interviews should not be given without prior approval of the primary spokesperson on a given issue or the employees' immediate supervisor.
- All media inquires of a political nature should be referred to the Communications Branch

In short, these guidelines made it clear that DFO staff were forbidden to criticize the department. This was regarded by many, both within government and outside, as a 'gag order'.

At the federal level, on 9 December the Treasury Board released a document to senior managers concerning the new Government Technology Centres Policy. This was intended to commercialize the operations of various federal laboratories by involving clients more fully in the management of technology centres, fostering effective technology transfer from government laboratories and facilitating the gradual privatization of certain centres where appropriate. This was another example of the trend to reduce federal research across the country.

In early December, more details were released regarding the transfers of some MEL positions to the Newfoundland Region. After various adjustments, 7 of the remaining 23 MEL PYs (30%), excluding the Biological Oceanography Division, were to be transferred, with or without incumbents. Mac Mercer, the Regional Director of Science in the Newfoundland Region, sent Barry Muir job descriptions of the new positions he wanted to fill. These were forwarded to Jim Stewart who in turn circulated them to BSB staff requesting expressions of interest. No one expressed interest in moving.

Also in December, Scott Parsons circulated the new objectives of DFO Science (including BSB, PCSB and CHS) which had recently been approved by the Treasury Board. He stated that the document served to clarify the role and direction of the Science program and to show that DFO remained firmly committed to longer-term research in support of its mission. However, the focus of biological objectives was on fisheries with limited reference to ecosystems.

1987

In early January, Jim Stewart formally announced the new organizational structure of BSB which incorporated the recommendations of the two internal review committees. This new organization was expected to serve for 1-2 years but adjustments and transfers might still be needed. The breakdown below, including PCSB, shows the divisions, managers and the assignment of MEL scientific staff not in the Biological Oceanography Division.

Biological Sciences Branch (BSB) (Jim Stewart, Director) (Hollis Building)

- Enhancement, Culture and Anadromous Fisheries Division (Neil MacEachern) (Hollis Building)
  Ken Freeman
- Invertebrate and Marine Plants and Environmental Ecology Division (Mike Sinclair) (Halifax Fisheries Research Laboratory)
  Gareth Harding, Peter Vass, Ken Mann, Nelson Watson, Dwight Reimer, Don Gordon, Barry Hargrave, Georgina Phillips, Peter Schwinghamer, Don Peer, Peter Cranford, Paul Kepkay, Azi Foda, Ray Sheldon and Ann Orr. Subsequently, this group became the Habitat Ecology Section headed by Don Gordon.
- Biological Oceanography Division (Trevor Platt) (BIO)
  Alan Longhurst and Brian Fraser
- Marine Fish Division (Don Bowen) (BIO)
  Lloyd Dickie, Paul Boudreau, Ken Frank, Jeff McRuer, Tim Lambert, Paul Brodie, Dick Dowd, Bill Silvert and Steve Kerr
- Fish Aquaculture and Applied Physiology (Bob Cook) (St. Andrews) (also Director of the St. Andrews Biological Station)
  No MEL staff

Physical and Chemical Sciences Branch (PCSB) (Jim Elliott, Director) (BIO)
- Coastal Oceanography Division (Clive Mason) (BIO)
  Ron Trites, Ken Drinkwater, George Taylor and Liam Petrie
- Ocean Circulation Division (Allyn Clarke) (BIO)
  No MEL staff
- Marine Chemistry Division (Mike Bewers) (BIO)
  John Vandermeulen, Maurice Zinck, Doug Willis, Richard Addison, Paul Keizer and Nick Prouse
- Metrology Division (Dave McKeown) (BIO)
  No MEL staff

Most of the MEL administrative staff were declared surplus, but fortunately many were able to find positions in the new Management Services and Comptroller branches.

In late January, Jim Stewart provided further details on the transfers of staff to the Newfoundland Region. These included fisheries as well as MEL staff. If an ample number of volunteers could not be found, it was announced that the PYs needed would be freed specifically for the purpose on the basis of program requirements and the merits of individual staff.

The widespread discontent among MEL staff in the Environmental Quality and Fisheries Oceanography divisions, to be disbanded on 1 April, continued. Scientific productivity suffered because considerable time was spent in impromptu hall gatherings and staff meetings to discuss the concerns of reorganization, downsizing, transfers to Newfoundland, new restrictive media guidelines and lack of understanding how science operated by those in Ottawa

making decisions about the changes. An overall concern was the lack of adequate communication between scientists and senior management and the apparent lack of understanding by senior managers of the critical importance of ecological research in resource management. A proposal was prepared and submitted to Barry Muir for a Scientists' Committee to improve communication but it never got anywhere.

MEL staff and university colleagues continued to solicit letters of support from scientific colleagues around the world protesting the funding cuts and pending demise of MEL. Numerous letters were sent to both Tom Siddon and Peter Meyboom. International respondents included John Sieburth (University of Rhode Island), Fred Grassle (Woods Hole Oceanographic Institution), Mike Mullin (Scripps Institute of Oceanography), Drew Carey (Oregon State University), Tony Rice (UK Institute of Oceanographic Sciences) and Henk Postma and Jena Zijlstra (Netherlands Institute of Sea Research).

In addition, Merrill Edwards of the University of New Brunswick and Chair of the Atlantic Provinces Committee on Sciences (APICS), of which DFO was a member, sent a letter to the Prime Minister and Atlantic Region MPs expressing concerns about the direction that federal science policy was heading. It seemed as if basic research was being put on the back burner and effort was concentrating on current technology. The disbanding of MEL was given as an example.

By now the situation had reached the boiling point. Wilfully breaking departmental media guidelines and risking losing their jobs, Lloyd Dickie, Ron Trites, Paul Brodie, Peter Schwinghamer and Paul Kepkay vented their frustration by conducting media interviews that questioned the logic and wisdom behind the decision made by Ottawa bureaucrats to disband MEL without consulting the scientists involved. Their message was two-fold: long-term research would suffer and the importance of multidisciplinary research was not appreciated. These interviews quickly led to a flurry of articles in the Chronicle Herald and Mail Star which helped bring the pending closure of MEL further into the public eye.

As expected, DFO management was not happy with these actions and letters of reprimand were issued to Lloyd, Ron and Paul Brodie for contravening the DFO media guidelines. As a result of this action, thirteen faculty members from the Dalhousie Department of Oceanography sent a letter to Tom Siddon protesting the disciplinary action taken against the MEL scientists for publicly criticizing the reorganization of DFO. Siddon later responded to Tony Bowen, Chair of the Department of Oceanography. To quote from his letter:

"I cannot agree that taking disciplinary action against an employee who publicly criticizes his employer infringes on his right to free speech. I am

surprised that the Department of Oceanography staff do not recognize that this is the norm for employees both within and outside the Public Service."

Eric Mills again entered the media fray by condemning the actions being taken by DFO on a CBC Sunday Morning national program on 1 March. Soon after, he received a letter from Scott Parsons chastising him for misreporting the facts. Parsons claimed that most DFO programs would continue as usual under the new organization and closed with some threatening words:

"Since you continue to distort the situation publicly, your actions would appear to be deliberate, with a result I can only describe as destructive and harmful to Canadian science. The Department of Fisheries and Oceans has a long history of collaboration and cooperation with Dalhousie University. Your continued misrepresentation of the intent and actual changes being implemented in DFO's Science programs put an unnecessary strain on a productive relationship that this Department values and wishes to retain in spite of your repeated misguided criticisms."

In his response to Parsons, Eric said that he resented the tone and content of the letter which he felt was not worthy of a senior administrator of Canadian science. He stated that different opinions existed over the way DFO had attempted to reorganize federal marine science and that:

"Resolutions of these problems will not be aided by attempts to silence people like myself, critics of policies and changes which have not received public scrutiny but which will affect the course of Canadian marine science for many years."

Further interviews condemning the closure of MEL were aired on the CBC soon after. One was done by Chris Taggart, a MEL postdoctoral fellow, on Information Morning in Halifax while another was done by Bill Leggett of McGill University on Maritime Magazine. These interviews stated that the breakup of a multidisciplinary marine research laboratory and assigning the scientists to a discipline structure was ill advised and a step backward.

About this time, a number of documents expressing the widespread discontent were prepared by several MEL scientists and submitted to Barry Muir. The dates and authors are not clear. One was a petition worded as follows:

"We the undersigned would like to convey to management our support for the five MEL scientists who have had the courage and conviction to speak out publicly, albeit as a last resort. At no time has management consulted with their working scientists on the dissolution of MEL. Our science has been seriously downgraded by regrouping us into disciplines. Not one environmental or fisheries problem can be solved by a single discipline yet there has been no effort to set up multi-disciplinary teams such as were present

in MEL. To add to our total frustration, we are told that we are being "rejuvenated" and science will not be adversely affected. It is high time management faced the scientists of the Marine Ecology Laboratory to explain their actions."

A second document detailed the concerns of MEL scientists, including:

- Lack of leadership
- Approach to scientific research and reorganization
- Guidelines for speaking to media and the public
- Research continuity
- Professional integrity

A third document provided a perspective on the destruction of MEL and the future of scientific research at DFO.

MEL scientists also raised their frustrations with their union, the Professional Institute of the Public Service of Canada (PIPS). The President, Iris Craig, agreed to come down from Ottawa on 19 March for a meeting with staff to discuss the situation. In discussions before she came, the local PIPS representative Wayne Rogers advised us that we should be careful not to let the situation get out of hand and cause wounds difficult to heal. If we continued to be activists, we should have objectives and a game plan. We needed to be constructive and to find ways to improve the situation. He advised preparing a list of clearly defined concerns to present to Iris Craig during her visit. This was done, and they included:

- Transfers to Newfoundland
- Downsizing
- Approach to scientific research and reorganization
- Media guidelines
- Leadership

The subsequent meeting allowed MEL scientists to express their concerns and provide Iris Craig with details of the actions being taken by senior management in reorganizing DFO Science without input from working scientists. No specific actions resulted from this meeting but Iris did return to Ottawa with a better appreciation of the reasons behind the widespread discontent.

On 23 March, Lloyd Dickie gave a most thoughtful and insightful talk in the BIO auditorium on his perceptions of what taking place in the reorganization of DFO Science and the demise of MEL (Dickie 1987). Lloyd, of course, was the founding director of MEL and had a long-standing interest in Canadian science policy. He presented his views on the problems, possible solutions and how to proceed to avoid useless confrontation.

He began by explaining that in the late nineteen-sixties and early nineteen-seventies there was a strong and growing interest in 'operations research'. This

was being recognized as a branch of cybernetic control theory and was rapidly becoming incorporated into a new theory of business management. A central figure in this movement was Stafford Beer, a British theorist, consultant and professor, best known for his work the fields of operational research and management cybernetics. He was the first to apply cybernetics to management, defining cybernetics as the *science of effective organization.* He was a persuasive intellectual and prolific writer whose clients included the governments of Britain, Canada, Chile, Denmark, France, Italy, Sweden and the USA. In 1973, he had been invited to Canada to express his views in the annual CBC Massey Lectures (Beer 1998). These views are illustrated by the following quotes:

"People do not know that there is a science of effective organization. What people say is that their own institution is unique. The consequences of this belief are bizarre. Our institutions are failing because they are disobeying the laws of effective organization, which their administrators do not know about and to which their cultural mind is closed".

"Science must be handled in a new way. We must remove control of science from the hands of those who now hold power over it and place it in the hands of people. We must remove the elitism of science. We must debunk the mysteries surrounding scientific work. The citizens have lost control of the choice of projects to be undertaken; this must be reversed."

"In order to maintain viability, the total system must have a central regulatory model. The precise form of variety attenuation is a matter for local decision. For this it is essential to dismantle the bureaucracy".

Beer strongly felt that government institutions must be radically redesigned to operate differently and showed how bureaucratic mechanisms had created stable, self-feeding and self-perpetuating institutions. He argued that the incorrect use of computers, telecommunications and information exacerbated the control problem and felt that governments must act to control these tendencies.

These views had a profound influence on the young Peter Meyboom, then with the Treasury Board, who soon became an ardent disciple of Stafford Beer and his management theories which had a major influence on Meyboom as he led the reorganization of DFO Science. Lloyd argued that Beer and Meyboom had a much different definition of 'science' than practicing scientists and that it was important we understand this difference in order to have effective debate between the new breed of senior administrators in DFO and ourselves. At the working level, we see science as the creation of new understanding. However, Beer and Meyboom saw science only as ordered knowledge and felt that scientific institutions are elitist with the goals of self-organization and self-perpetuation that do not address to the real needs of the people. Lloyd further

argued that we needed to find the means of accommodating our aims and practices as scientists to those defined by this rather simplistic view of science which was infiltrating DFO. For example, our senior managers now defined 'oceanographic science' as what the clients want done in the ocean. Therefore, if there is no client, there is no need and not the business of government to support it.

Lloyd suggested that the real problem we faced arose in the literal application by Peter Meyboom of these operation research ideas down to the level of institutions such as MEL and practicing scientists. We needed to find solutions to reconcile these different points of view, a process which would take time. He felt that the first stages of the current DFO Science reorganization witnessed so far had been ignorant, dishonest and intolerable. As a result, all had suffered and we would suffer a great deal more if we continued on the same course with no communication. Lloyd argued that neither we nor our immediate bosses had really understood what is going on at the top. Instead, we had been swamped by a secondary struggle, in which events were driven by quite different motives and generated separately in the middle management levels of DFO. We as scientists should be clear on our understanding of scientific research, scientific information and scientific development and agree on the proper content and balance. This then could be communicated up the line to our senior managers.

He then presented his views of these topics. Scientific research is an activity that we all knew about. In the case of MEL, it had been multidisciplinary research to create new ways of looking at problems and finding implied new ways of solving them. Over the years, we had been working in the right direction and making important strides toward our objectives. However, from our perspective, our work was not always recognized in DFO and at times the knowledge we had compiled was actually blocked at middle management levels by people who were probably working on a different model than Meyboom or us.

Scientific information is a complex undertaking that had been badly neglected by both scientists and managers in DFO. It consists of telling the appropriate people what science does and can do. This exercise should be done by lab directors and scientists themselves and not left to the media. We had spent far too little effort trying to reach out to the appropriate public or even to define it.

With regard to scientific development, which includes the application of research results to management, Lloyd argued that this had been poorly handled by Canadian government from the very beginning because of the pressure for quick solutions. It had been easy to slip into thinking only in terms of information and terminology applied at the top by someone like Beer. As a result, existing information had been applied to solve problems according to existing paradigms and there was need for radical change. He suggested that

instead of dedicated managements agencies in science itself we needed more responsible organizations that could take new ideas and express them as potential control measures in actual practical terms. As we now worked, we had placed this job in the hands of institutions which themselves have as a main output their own preservation.

In his closing words, Lloyd wondered if we scientists had the will or energy to sufficiently understand the nature of the problems affecting us. Are we clear in what we mean by science and people? Do we know the consequences of the various points of view for our own professional activity? He emphasized that the basis of our work is being challenged by a forceful intelligent man, Peter Meyboom, who knows what he thinks about all of this. He said that Meyboom might be willing to come to BIO to discuss the situation. If we did not understand him enough to have him understand us, we will have lost the opportunity for any real dialogue. We should not be confused and become prey to the motives which generated this situation in the first place, namely the movements of a bureaucracy of middle managers who have seen in the thinking of Beer and Meyboom a mechanism for their own self-preservation. He concluded by saying that until he was convinced that there were no other hidden agendas around he was not prepared to take on faith that we are either on the right track or the track intended by Meyboom.

Under the lead of Alexa McDonough, the issue of the MEL closure was raised again in the provincial House of Assembly. She wanted the province to formally protest the decision but no action was taken.

All the protesting actions taken by MEL staff, Dalhousie colleagues, and prominent marine scientists from around the world had no apparent impact on the decisions being made by DFO senior management. As described in *The Chaining of Prometheus* (Hayes 1973), we were witnessing the imposition of top-down management with research planning, programming and budgeting (PPB) centered in Ottawa, with minimal communication with the regional science staff being adversely affected. So ended a hugely successful 22-year experiment of embedding a laboratory with a loosely defined mandate for basic ecosystem science within a federal government organization in which science was becoming more goal-oriented and subject to detailed planning by managers that might or might not have scientific aims in mind.

A subdued farewell party was held on 31 March. The following day, under the lead of Lloyd Dickie and Ron Trites, over 100 staff, including non-MEL scientists, gathered at noon at the main door of BIO wearing black arm bans to stage a ‘wake for marine science’ protesting the closure. They wanted to show that MEL’s demise was not opposed by just a small band of malcontents, as Siddon had stated several days earlier in the House of Commons, but was also opposed by much of the scientific community in Atlantic Canada and marine

scientists around the world. In a statement distributed to the press, the scientists said:

"We have made many efforts to voice our scientific concerns to the minister, including a petition this last week with 150 names appended. These have been ignored. Instead, an atmosphere of confrontation has been created which makes rational discussion impossible. As concerned scientists and responsible citizens, we have concluded that our perception and our experience are too important to be disregarded."

Demonstration at BIO entrance protesting the closure of MEL
1 April 1987

Details of this demonstration, including interviews with Lloyd Dickie and Ron Trites, were reported by Charbonneau (1987). They recognized that there were long standing different views of priorities in the DFO fisheries and oceanography programs and expressed the opinion that fisheries wanted to take oceanography apart. They felt that middle managers got rid of the special structure for oceanography in DFO and put it under fisheries with guise of responding to cutbacks but in fact were suiting their own long-term strategy. They realized that there were lots of things wrong with the way science was organized in Canada and that re-organization was not a bad thing in itself. All parties should be open enough to take a look at this. But why disband something that has been working well? They stated that senior managers in DFO had long been known for their paternal attitude about everything; they know better than anyone else what to do and everyone else had to fall in line. They were also upset at the apparent shift away from the multidisciplinary, long-term research carried out by MEL towards short-term managed research directed at the day-to-day running of the fisheries. Also at issue was the right of scientific staff to speak out on what they considered important professional issues. This act of mourning the demise of MEL was a symbolic expression of the concern that the requirements of scientific research in fisheries and

oceanography were not understood or supported by the senior managers of DFO. It was indeed a dark day for Canadian marine science.

Concerned about the unrest, Peter Meyboom visited BIO a few days later and gave a presentation to all DFO staff in the auditorium explaining the basis for his decisions. As expected, he was coldly received, but at least he had the courage to come down from Ottawa and face an open and somewhat hostile audience. As reported by Charbonneau (1987), he led a frank and useful exchange of views with scientists and emphasized that there was no hidden agenda. He said that emergence of this whole issue was very surprising to him and felt the concerns were based on speculation. No scientist had called him up in Ottawa and asked for the truth. Instead, he felt that scientists had fired each other up in ways not helpful in understanding the situation. He recognized that there obviously was a serious lack of communication. However, he emphasized that scientists were not correct in speaking out about the situation since that was against government policy. He stated that it was necessary to amalgamate oceanography and fisheries in DFO because of the pressure to downsize but that, while some names were disappearing from the organizational structure, functions were not. They were just being redistributed. He said that, in his view, neither long-term or multidisciplinary research were threatened, and he invited MEL staff to form a group of senior scientists to advise the Regional Science Director, Barry Muir, and other managers at BIO on how to safeguard these important aspects of their work.

After the meeting with Meyboom, Lloyd stated that he was satisfied that scientists would now have reasonable input into what is happening. The atmosphere of confrontation was diminished. However, despite some fence mending, there was still some underlying cynicism about what would happen next in the science integration. Most MEL scientists believed Meyboom was sincere but were not sure if he would be able to deliver on his promises.

Shortly after, responding to the invitation of Peter Meyboom, Ron Trites took the lead in establishing a Scotia-Fundy Scientists' Committee for promoting open two-way communication between working scientists and senior management. Several meetings were held but interest in this endeavour rapidly faded and it is not clear if any documents were prepared and submitted to Barry Muir.

With time, DFO backed off on the number of MEL positions to be transferred to Newfoundland. After considering the changing research environment at BIO, Ray Sheldon, Peter Schwinghamer and Madhu Paranjape decided to volunteer and moved to Newfoundland, along with Tim Foulkes from St. Andrews. In the end, no one was forced to move against his or her will, as earlier threatened.

With the intent to carry on the spirit and legacy of MEL, Ron Trites and Lloyd Dickie led the creation of the MEL Society. Several meetings held were held, by-laws drafted and a lapel pin designed and produced for members to wear with pride. However, after a few years when the dust had settled, this society fizzled out.

LEGACY

In April 1987, all of BIO entered the new fiscal year facing a high degree of uncertainty and this was especially so for ex-MEL staff. Their beloved laboratory, highly respected in the international scientific community, was no more and they were entering a new world of science organization under increasing domination from Ottawa. Due to the unpopular reorganization and funding cuts, morale at BIO was very low. However, the situation started to improve immediately after Barry Muir departed as Regional Director of Science in early May to return to Ottawa. His unenviable job as hatchet man was over. He was replaced by Steve McPhee who had previously worked at BIO as the Head of the Engineering Services Division before moving to Ottawa to become Dominion Hydrographer. Steve's arrival back at BIO was a breath of fresh air for all and helped to get morale back on track.

Some positive organizational adjustments followed soon after. In 1988, Mike Sinclair took over from Jim Stewart as Director of the Biological Sciences Branch (BSB). Jim, a microbiologist in training, moved from the Hollis Building in Halifax to BIO to resume a full-time career as a research scientist after serving many years as a DFO research manager. Mike immediately started to make a number of organizational changes to repair some of the damage done by closing MEL. One of these was creating the Habitat Ecology Division which was headed by Don Gordon. This new division reunited many ex-MEL scientists and also included some scientists with habitat interests from other divisions. The staff included Lloyd Dickie, Steve Kerr, Paul Boudreau, Bill Silvert, Paul Brodie, Ken Mann, Subba Rao Durvasula, Ann Orr, Gareth Harding, Barry Hargrave, Georgia Phillips, Don Peer, Peter Cranford, Dwight Reimer, Peter Vass, Jim Stewart, Linda Marks, Shoukry Messieh, Terry Rowell, Patrick Woo and Nelson Watson. Soon after, Paul Keizer and Tim Milligan were transferred into Habitat Ecology from the Marine Chemistry and Coastal Oceanography divisions of PCSB. Still later, Cynthia Bourbonnais transferred over from the Marine Fish Division. These moves created a broad multidisciplinary division of scientists with specialities in chemistry, sedimentology, microbiology, phytoplankton, zooplankton, benthos, fish, marine mammals and theoretical ecology. In essence it was a miniature MEL and those included were most pleased to be part of it. This new division played the leading role in responding to the need for DFO Science to address the demands of the new departmental fish habitat policy and close collaboration was established with habitat managers. In addition, Mike Sinclair made other positive staff transfers between other BSB divisions after consulting those

involved. In the end, after these organizational adjustments, all BSB staff were located in the division of their choice and a new equilibrium was established. Most fortunately, the closure of MEL was not the end of marine ecological research at BIO as some at first had feared. While MEL ceased to exist as an organization on paper, most of the scientific staff remained. Only six departed. Ray Sheldon, Peter Schwinghamer and Madhu Paranjape voluntarily transferred to the Newfoundland Region, John Smith was transferred to the Gulf Region while Ross Shotton and Pat Ahern were declared surplus. While not happy with the decisions that had been made, most remaining staff were realistic enough to accept and adapt to the new working conditions. While now scattered around different divisions in BSB and PCSB under the DFO Regional Director of Science, they were able to continue most of their previous ecological research projects, and initiate new ones as resources allowed, with the full support of local management.

However, all was not rosy as various external constraints placed limits on BIO research. Funding cuts continued into the 1990s and beyond. For example, as a result of the federal government Program Review under the Chretien Government in 1995, the DFO Maritimes Region Science Branch was hit with approximately a 40% reduction in staff and financial resources. Early retirement incentives were established and many older staff took advantage of them and departed. New staffing opportunities were scarce so retiring staff were rarely replaced which led to a gradual decline in scientific expertise. There was very limited opportunity to hire recent graduates full of new ideas and skills eager to establish careers in marine science as Lloyd Dickie had been able to do in the formative years of MEL. Further cuts were made to science funding in the early 2000s by the Martin Government in their attempt to reduce the national debt. Yet further cuts were made later under the Harper Government, which had a particularly negative view of science (Turner 2013).

This continued loss of scientific expertise and A-Base funding severely hampered BIO's ability to carry out its core research programs in all disciplines. The era of science-driven basic research in federal laboratories was largely over and scientists had to pay more attention to addressing the more immediate and practical needs of DFO fisheries and habitat managers, other government agencies and industry. Increasing emphasis was placed on developing partnerships with other federal labs, universities and industry. The trend of going after external funding had started several years earlier with the Unsolicited Proposal and PERD programs. Fortunately, with time some additional programs were established within DFO and other departments and agencies to which BIO scientists could apply for B-Base funding. With time, these became very important, if not essential, sources of funding. Such programs in DFO included the Long Range Transport of Atmospheric Pollutants (LRTAP), Marine Phycotoxins, the Green Plan, the Strategic Science Plan, the Atlantic Fisheries Adjustment Project (AFAP) and the Northern Cod Program. The Department of Indian and Northern Affairs

(DIAND) provided substantial funding for research on organic contaminants in the Arctic. Another funding source was the Environment Studies Research Fund (ESRF) administered by the oil and gas industry. Numerous Joint Project Agreements (JPA) were established with the fishing industry. Many other sources were exploited as well. These efforts required considerable time for preparing proposals, attending funding meetings and preparing reports. Unlike their university colleagues, most DFO scientists had little previous experience in the field of grantsmanship and had to learn much along the way. As a result of these changes in the sources of funding, lab directors lost considerable control of their laboratories' research programs because, after salaries were paid, there was limited A-Base funding for them to use at their discretion. As a result, research projects became more applied in nature and heavily influenced by the agendas of other agencies.

Another serious factor limiting BIO research capability after the closure of MEL was the steady erosion of the research vessel fleet. While increasing use was gradually being made of ocean moorings and satellites, ships were still essential for most oceanographic programs. Most BIO vessels had been built in the 1960s and, as they were retired, they were not replaced. By 2001, only the *Hudson* and *Needler* remained for offshore oceanographic and fisheries work. With advancing age, their reliability decreased and the frequency of breakdowns increased. This necessitated the increasing use of charter vessels which were not always ideal for the tasks at hand.

By the early 1980s, BIO had developed the reputation of being one of the best oceanographic laboratories in the world, on par with the Woods Hole Oceanographic Institution and Scripps Institute of Oceanography. Unfortunately, as a result of dwindling resources and increasing control from Ottawa, the more fundamental oceanographic research programs were markedly reduced and increasing restrictions on travel made it difficult for BIO scientists to participate in international professional activities. As a result, BIO started to lose some of its enviable status as an oceanographic institute of international standing.

This significant erosion of oceanographic research at BIO was not immediately visible from the outside. Despite the loss in scientific staff, the total number of employees at BIO remained fairly constant at about 600 as existing non-science units expanded, new ones were created and others moved in from other locations. With time, all DFO management and administrative components scattered around Metro were consolidated at BIO. This included the Canadian Coast Guard so there were always lots of ships docked along the waterside. As a result, the composition, culture and atmosphere of BIO underwent a major shift as the emphasis switched from oceanographic research to running a federal government department with numerous legislated mandates and wide-ranging operational responsibilities.

Following the merger of OSS and the Fisheries Resource Branch and the closure of MEL in 1987, the organization and operation of DFO research at BIO continued to evolve, although at a reduced level. These changes were the result of various factors including the turnover of managers, on-going funding cuts, the need to consolidate dwindling research expertise, new federal legislation, external events, the need to respond to industry requirements and international agreements. These operational changes, up to 2012, have been documented in the BIO Chronology (Gordon 2018) and some of those influencing the direction of marine ecological research at BIO are summarized as follows.

1987

With the new DFO fish habitat policy released in 1986, habitat managers were faced with making decisions that affected both habitat and project developers. The multidisciplinary aspects and complexity of many project proposals necessitated habitat managers to seek scientific advice from BIO scientists. Therefore, steps were taken to improve the linkages between BIO scientists and staff of the regional Habitat Management Branch, located in Halifax, managed by André Ducharme. For several years, staff participated in national committees established to define the operational procedures for implementing the new fish habitat policy across the country. The Marine Assessment and Liaison Division (MALD) was established under the Regional Science Director and headed by Brian Nicholls. It coordinated the provision of BIO scientific advice from all oceanographic disciplines to habitat managers on a wide variety of marine and freshwater habitat issues. This mechanism allowed scientists and managers to work together to make scientifically based decisions on proposed development projects. Meetings involving habitat and science managers from all four Atlantic regions were held three times a year to review the major habitat issues facing DFO and discuss the requirements of habitat managers for new scientific information. To address these needs, numerous new research projects were initiated by Science, one example being the ten-year program to investigate the impacts of mobile fishing gear on benthic habitat and communities (Gordon and Kenchington 2014). 'Habitat' became a new buzz word and was frequently used in place of 'ecosystem' in project documentation. While most projects were applied in nature, they did provide an opportunity to do some exciting research of international significance. The Habitat Management Branch later moved to BIO and became an integral part of the expanding DFO ecosystem management community (Murphy et al. 2014). These steps ensured that DFO Science was effectively providing the scientific advice requested by habitat managers.

1992

The collapse of east coast groundfish fisheries led to the closure of most groundfish fisheries north of Halifax, including the Gulf of St. Lawrence and Grand Banks. These collapses produced a number of significant changes in fisheries research at BIO. It was realized that focus on single-species

management had taken attention away from the need to conserve ecosystems, and fisheries scientists continued to expand research dealing with an ecosystem approach to fisheries management. The fishery collapses stimulated the BIO fisheries research community to address the causes as well as the lessons that could be learned from this experience in order to improve the advisory products and management systems. These expanded studies included evaluating the role of grey seals in the dramatic increase in the natural mortality of groundfish.

1995
Steve McPhee stepped down as the Regional Director of Science and returned to Ottawa to become Director General of the Canadian Hydrographic Service. He was replaced on an acting basis by Jim Elliott.

In another major reorganization, the Biological Sciences Branch (BSB) and the Physical and Chemical Sciences Branch (PCSB) were dissolved and staff were merged into a new divisional structure. The four previous PCSB divisions plus the BSB Biological Oceanography Division were merged to create a large Ocean Sciences Division headed by Jim Elliott. The Habitat Ecology and Marine Chemistry divisions were merged to create the Environmental Sciences Division which was headed initially by John Pringle and subsquently by Paul Keizer.

1996
John Loch arrived from the Gulf Region to become the new Regional Science Director and Mike Sinclair took over as the manager of the Marine Fish Division.

1997
The Halifax Fisheries Research Laboratory was closed. Most of the staff moved into the newly renovated Fish Lab at BIO and became part of the new Invertebrate Fisheries Division.

The Canadian Atlantic Fisheries Scientific Advisory Committee (CAFSAC) was disbanded and replaced by the Regional Advisory Process (RAP) which fostered broader participation by stakeholders in the scientific peer review of fishery management advice. Its mandate expanded to include the conservation of marine and freshwater aquatic resources and their habitats. This new office, headed by Bob O'Boyle, was housed at BIO.

Canada enacted the Oceans Act which made Canada the first nation in the world to have comprehensive oceans management legislation. The three parts laid the foundations for modern oceans governance in Canada. Part I defined Canada's maritime territory, including the declaration of an Exclusive Economic Zone in accordance with the provisions of the United Nations Convention on the Law of the Sea. Part II assigned a leadership role to the

Minister of DFO for oceans stewardship and the management of activities affecting estuarine, coastal and marine ecosystems in Canadian waters. Part III clarified and consolidated federal oceans responsibilities. Overall, the Oceans Act enshrined the fundamental principles of sustainable development, the precautionary approach and integrated management, and called for collaborative and cooperative management arrangements that respect assigned constitutional and legislative responsibilities including Aboriginal and treaty rights. To facilitate the implementation of the Act in the Maritimes Region, the Oceans Act Coordination Office (OACO) was established at BIO and headed by Faith Scattalon.

1999
The Gulf Region was re-established and the Gulf Fisheries Centre was established in Moncton, NB.

Driven by the United Nations Convention on Biological Diversity, the Centre for Marine Biodiversity (CMB) was created and Ellen Kenchington was appointed as Director. This initiative involved partnerships among government agencies, universities, industry and NGOs and led to larger national and international initiatives such as the Barcode of Life program and the NSERC Canadian Healthy Ocean (CHONe) university research network.

Under the lead of the Oceans Act Coordination Office, a pilot project entitled the Eastern Scotian Shelf Integrated Management (ESSIM) was initiated and numerous BIO scientists participated. ESSIM was a collaborative planning process within and among all levels of government and numerous stakeholders with diverse interests which included marine conservation, oil and gas, academia, coastal communities, transportation, telecommunications and tourism. There were three major components to ESSIM. The Forum was the collective body of all stakeholders for information exchange and feedback and to provide the overall vision and principles. The Stakeholder Roundtable, which had approximately 26 members representing all stakeholders, worked with the Planning Office to provide leadership and coordination. The Planning Office, located at BIO, was responsible for overall leadership and coordination. This initiative took five years to develop an integrated management plan.

2000
Mike Sinclair replaced John Loch as the Regional Science Director.

The Oceans Act Coordination Office continued to expand and evolved into the Oceans and Environment Branch, still managed by Faith Scattolon. This new branch included the Habitat Management Division, the Marine Environmental Sciences Division and the Oceans and Coastal Management Division.

The Enhancement, Culture and Anadromous Fisheries Division was consolidated at BIO after years of being spread across a number of locations.

The concentration of fisheries science expertise at BIO was now the greatest it had ever been since its founding in 1962. In addition, the Habitat Management Division moved from the Maritime Centre to BIO.

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. Shubha Sathyendranath, wife of Trevor Platt, was appointed as Executive Director.

2001
Glen Harrison took over from Trevor Platt as manager of the Biological Oceanography Section in the Ocean Sciences Division.

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 across the country. 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.

2002
The Species at Risk Act (SARA) received Royal Assent and a Maritimes Region office was established at BIO with John Loch as manager. SARA became an important tool for conserving and protecting Canada's wildlife biodiversity. While administered by Environment Canada, DFO shared responsibility for its implementation and management. In particular, DFO was responsible for the aquatic species listed under SARA which included all life stages of fish, shellfish, crustaceans, marine animals and marine plants. SARA complemented the Fisheries Act and the Oceans Act which protected and conserved species not listed under SARA. SARA established a process for conducting scientific assessments of the conservation status of individual wildlife species and provided a mechanism for listing species assessed as extirpated, endangered, threatened or of special concern. SARA provided legal protection to listed wildlife species and their critical habitat and required the preparation of recovery plans for listed species.

The Marine Environmental Sciences Division was moved back to the Science Branch.

2004
The Oceans and Environment Branch became the Oceans and Habitat Branch with Faith Scattolon continuing as director.

The International Ocean Colour Coordinating Group (IOCCG) office was established at BIO and headed by Venetia Stuart. The IOCCG is an international committee of experts with representatives from national space

agencies as well as the ocean colour and inland water user communities around the world. Operating under the auspices of the Intergovernmental Oceanographic Commission (IOC), it promotes the application of remotely-sensed ocean-colour/inland water radiometry data across all aquatic environments, through coordination, training, liaison between providers (space agencies) and users (scientists), advocacy and provision of expert advice. The IOCCG also has a strong interest in capacity building, and sponsored advanced ocean colour training courses in various countries around the world.

2005
Further major changes in the organization of the Science Branch were brought about by the need to consolidate the dwindling staff and eroding financial resources. The Diadromous Fish, Invertebrate Fisheries and Marine Fish divisions were merged to create the Population Ecology Division headed by Ross Claytor. The Marine Environmental Sciences Division and the Biological Oceanography Section were merged to create the Ecosystem Research Division headed by Tom Sephton.

2006
The Regional Advisory Process (RAP) office morphed into the national Canadian Science Advisory Secretariat (CSAS), still headed by Bob O'Boyle. Carrying on in the same tradition, CSAS coordinated the peer review and drafting of expert scientific advice on a broad range of management issues brought forth by habitat, oceans, species at risk and fisheries managers so they could make informed decisions.

2007
The Marine Chemistry Section of the Ecosystem Research Division was terminated. This marked the end of a 27-year history of BIO having a research unit devoted to chemical oceanography and contaminants.

Paul Boudreau took over the management of the Canadian Science Advisory Secretariat (CSAS) office.

2008
The Oceans and Habitat Branch evolved into the Oceans, Habitat and Species at Risk Branch with Mike Murphy taking over as director.

Alain Vezina became the manager of the Ecosystem Research Division which now consisted of three sections:

- Centre for Offshore Oil and Gas Environmental Research (Ken Lee)
- Habitat Ecology (Ed Kennedy)
- Ocean Research and Monitoring (Glen Harrison)

2009
This was the last year that BIO published an annual report, a tradition carried on since the founding of BIO in 1962. These documents provide a valuable source of information on how BIO and its components evolved and their accomplishments. This year listed a total of 365 DFO Science staff, including the Canadian Hydrographic Service, and 75 DFO Oceans, Habitat and Species at Risk staff.

Ed Kennedy took over as manager of the Ecosystem Research Division.

2010
Mike Sinclair retired as regional science director and was replaced by Alain Vezina.

The Tuesday Club was renamed the BIO Campus Management Committee. With membership from all departments on the BIO campus (DFO, NRCan, EC, DND and Public Works), it continued to be responsible for the management of activities and processes common to all scientific, operational and policy organizations on the BIO campus.

In addition, a new Science Management Committee was established to focus on research issues with membership from the four science departments on the BIO campus (DFO, NRCan, EC and DND). The mandate of this committee was to 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 David Millar took over as director.

2012
Tana Worcestor took over the management of the Canadian Science Advisory Secretariat (CSAS) office.

The remaining DFO scientific staff (with the exception of the Canadian Hydrographic Service), including the programs at both BIO and St. Andrews, were now consolidated into just three divisions:

- Coastal Ecosystem Science Division and St. Andrews Biological Station (S.E. McGladdery) (St. Andrews)
    - Habitat Ecology Section (Ed Kennedy) (BIO)
    - Coastal Oceanography and Ecosystem Research Section (Fred Page) (St. Andrews)
    - Biological Effects Section (L. Cooper) (St. Andrews)
- Ocean and Ecosystem Sciences Division (Charles Hannah) (BIO)
    - Centre for Offshore Oil and Gas Environmental Research (Ken Lee) (BIO)
    - Marine Ecosystem Section (Bill Li) (BIO)
    - Oceanography and Climate Section (Blair Greenan) (BIO)

- Population Ecology Division (Ross Claytor) (BIO)
    - Administration Management Section (Jim McMillan) (BIO)
    - Eastern Scotian Shelf Section (Ross Claytor) (BIO)
    - Gulf of Maine Section (Don Clark) (St. Andrews)
    - Inshore Western Section (Shane O'Neil) (BIO)
    - Western Scotian Shelf Section (Peter Hurley) (BIO)

By this time, the importance of understanding the structure and dynamics of marine ecosystems and how they can be influenced by human activities and climate change was more widely appreciated throughout DFO. It is interesting to note that all of the three remaining research divisions at BIO now had either 'Ecosystem' or 'Ecology' in their name. This is in sharp contrast to 25 years earlier when senior DFO managers in Ottawa terminated its only laboratory dedicated solely to marine ecological research. What would Peter Meyboom think if he was alive today?

As is now evident, the closure of MEL was not the end of ecological research at BIO but represented a major turning point. Most of the continuing ecological research at BIO was initially carried out in the well-established Biological Oceanography Division and the newly created Habitat Ecology Division, as well as the Marine Fish Division. The Biological Oceanography Division was actually little affected by the organizational changes and was able to carry on without interruption much of its program of basic research on marine production processes at local, regional, national and global scales. In contrast, the newly created Habitat Ecology Division established a series of more applied projects at local and regional scales to address the expanding needs of habitat managers under the new national DFO fish habitat policy. Most of these projects addressed understanding the impacts of human activities such as aquaculture, oil and gas development and fishing on marine ecosystems. One new main thrust was the mapping of offshore benthic habitat using new acoustic technology in collaboration with the Geological Survey of Canada (Atlantic) and the Canadian Hydrographic Service.

Later on, when some resources became available, DFO was able to hire some new ecologists to help compensate for the earlier losses to retirement. These included Melissa Wong, Herb Vandermeulen, Claudio Dibaco, Katherine Johnson, Nancy Shackell and Brent Law. While having much reduced resource levels and having to deal with more bureaucracy than their predecessors, they have able to develop important new ecological projects and carry the MEL tradition further.

Recognizing that proper management required more information than just the internal dynamics of individual fish stocks, the Marine Fish Division (MFD) continued to give increased attention to ecological considerations in fisheries management and initiated a number of new ecosystem level research projects (O'Boyle et al. 2014). The need for ecosystem models that proposed plausible

hypotheses of ecosystem functioning was realized which in turned required theoretical developments in ecosystem control, spatial dynamics and habitat-productivity linkages. In addition, the importance of environmental monitoring programs was well recognized.

Another factor which led to the development of new ecological programs at BIO was the passing of the Oceans and Species at Risk acts. Implementation of these acts required that DFO undergo a paradigm shift in oceans management that extended beyond traditional fisheries and habitat management and considered other users. As a result of these new legislative mandates, new projects with an ecological focus were initiated by the recently arrived staff. In addition to some limited research, these including preparing synthesis reports, status reports and recovery plans for threatened species as well as leading the development of integrated ocean management plans for large spatial areas and marine protected areas (MPAs). By 2010, these diverse marine management activities at BIO, designed to assist decision making across multiple sectors of ocean users, were consolidated in the Ecosystem Management Branch (Murphy et al. 2014).

Examples of ecological research carried out at BIO after the closure of MEL in 1987, both by ex-MEL staff and others, up to 2010 are listed in Appendix 5.

SYNTHESIS

This section presents an overview of what I think are the most important highlights in the twenty-two year history of MEL. As well as scientific accomplishments, it also addresses the working environment, interactions with the broader scientific community, its demise and its legacy. While I have endeavoured to keep the previous sections objective, this section is somewhat subjective and not all may agree with my conclusions.

Fulfilling Its Mandate

The original mandate of the Marine Ecology Laboratory (MEL), carried over from it's predecessor the Atlantic Oceanographic Group (AOG), was to study the oceanic processes underlying marine production in both inshore and offshore waters with special reference to fish. This included studying the structure of marine ecosystems, both pelagic and benthic, and the rates of energy transfer between the different trophic levels supporting commercial fisheries. Elucidating the role of controlling physical, chemical and geological oceanographic processes was critical to its success. In 1970, the mandate of MEL expanded to include studies of the impacts of human activities on marine ecosystems. Initial environmental work focused on chemical contaminants such as chlorinated and petroleum hydrocarbons but later expanded to include the impacts of physical habitat disturbance. Because of the nature of its mandate, MEL scientists needed to think 'big' and carry out multidisciplinary

programs. Most MEL research was basic in nature and international in scope. While there was a requirement to provide ecological advice as requested, there was no direct involvement in fisheries management. This mandate focusing on marine ecology was quite unique at the time when other federal marine labs were focused primarily on fisheries and technology. Over its twenty-two year lifetime, MEL faithfully lived up to its mandate and its success is well illustrated by its exceptional scientific productivity.

Unique Situation

MEL was able to flourish because it was most fortunate to have been at the right place at the right time. The circumstances under which it developed were really quite exceptional, like riding the crest of a wave. It did not have to start from scratch but instead developed on the firm foundation laid down by the Atlantic Oceanographic Group (AOG) of the Fisheries Research Board. It was extremely fortunate to have been situated at the Bedford Institute of Oceanography (BIO). This unique federal facility had been built specifically for oceanographic research of all disciplines. Different federal government departments with marine research mandates shared an extensive infrastructure which included carefully designed research laboratories, a marine sciences library, computer centre, machine shops and a world-class fleet of research vessels. BIO programs covered all the major marine science disciplines including hydrography, physical oceanography, chemical oceanography, geophysics, marine geology, marine ecology and fisheries. The extensive area of operations covered coastal waters, the bays and continental shelf off Atlantic Canada, the eastern Arctic and international waters. In addition, Dalhousie University with its marine science programs was just across the harbour in Halifax, and the Defence Research Establishment Atlantic (DREA) of the National Department of Defence was just down the road in Dartmouth. MEL was just one part of the large dynamic oceanographic community of international stature in the Halifax/Dartmouth metro area that could share ideas, facilities, seminars and visitors.

MEL developed at a time when marine science was a high federal priority in Canada and, as a result, it was well supported and for most of its history enjoyed a relatively stable research environment. It was a unique federal scientific organization, the only one of its kind in Canada with a program focused on marine ecosystem research. Most funding was A-base under the direct control of the founding director, Lloyd Dickie, so there was no need to play the game of grantsmanship. There was a minimum of administrative red tape. With few exceptions, staff occupied permanent positions with generous benefits and pension plans. Under the Fisheries Research Board, Lloyd had almost complete authority to run the lab as he wished and was personally responsible for recruiting most of the staff. He possessed a knack of assessing potential staff and selecting the most suitable. The ideal working environment at BIO attracted top-notch people and during his term as director he built a

dream team of scientific staff. Scientists were given a large degree of freedom in selecting the details of their individual research projects as long as they fell under general MEL mandate. Scientists were free to take risks and explore new ideas and techniques and therefore their research tended to be more basic than applied in nature. As a result, the staff was highly motivated and the working environment was much more like a university than a federal lab. As an integral part of BIO, MEL became a coveted place to work and very few staff left for employment elsewhere. All three permanent directors were themselves distinguished scientists and highly regarded in the international scientific community.

While unique in Canada, other marine labs around the world were also studying various aspects of marine ecology but with time MEL earned the reputation for being one of the best, both in Canada and abroad. One of the few comparable laboratories was perhaps the marine food chain group at the Scripps Institute of Oceanography that had been developed under the leadership of John Strickland who had previously worked at the Fisheries Research Board's Pacific Biological Station in Nanaimo, BC. It was most appropriate that the new wing built for MEL at BIO was named for him.

While each BIO laboratory was independent and responsible for its own programs, a committee of science directors, all of whom had a strong scientific background, met on a regular basis to manage overall institute business, discuss sharing of resources, promote collaborative research and encourage a collegial atmosphere. For most of MEL's existence, the other principle science labs were the Atlantic Oceanographic Lab (AOL) and the Atlantic Geoscience Centre (AGC), and later the Marine Fish Division (MFD). As a result of this arrangement, there was an effective informal horizontal structure in the Institute that crossed departmental and branch lines. This encouraged the creation of numerous multidisciplinary projects that were important in addressing the MEL mandate of developing understanding of marine ecosystems underlying fisheries. The fact that staff regularly crossed paths in the halls, in the library, in the cafeteria and seminars led to the productive exchange of ideas and information. Many projects began over a cup of coffee. Advice on almost any oceanographic question was available just down the hall. MEL played an important role in BIO achieving the recognition of being one of the major oceanographic institutes in the world, as originally envisioned by William van Steenburgh when BIO opened in 1962.

People

Much credit needs to be given to Lloyd Dickie for recruiting such a unique group of talented, creative and dedicated scientists during the formative years of MEL. While all had their individual areas of expertise, they also had the interest and ability to look at the bigger picture and take a broad ecological outlook in their research. Most were able to switch fields and start new

projects when warranted. While some came from the US or UK, most were trained in Canadian universities, especially Dalhousie. There was quite a blend of personalities and at times there was some friction between certain staff members but by and large it was a most stimulating, pleasant and collegial working environment. Groups met regularly for coffee in the morning and tea in the afternoon. In addition, there were many social and outdoor activities outside of regular working hours which included dinner parties, picnics, spring canoe trips down the Shubenacadie River to pick fiddleheads, trout fishing trips down the eastern shore, canoe trips to Kedge, hiking and cross-country skiing.

The quality of MEL staff is well illustrated by several indices. From the very beginning, emphasis was put on publishing research results in the primary scientific literature and MEL staff excelled at this. The publications were a major criterion for promotion and MEL research scientists repeatedly did very well in the annual national promotion process. This caused some discontent with the directors of other labs whose scientists were required to spend more time on advisory/management activities that did not produce primary publications. Many felt that advisory publications did not receive the proper credit they were due. On occasion, some directors complained that MEL scientists had more time for "their own work" compared to scientists other government labs. Scientists in other units often felt that MEL scientists were treated as elite.

Over the years, MEL scientists received a large number of major awards which are documented in Appendix 3. All three directors, Lloyd Dickie, Alan Longhurst and Ken Mann, returned to research when they stepped down and were elected to the Royal Society of Canada. The most decorated MEL research scientist was Trevor Platt. Over the years, MEL scientists, including all three directors, produced a number of major books which are listed in Appendix 4.

It is interesting to note the indirect influence of G. Evelyn Hutchinson on the development of MEL. Hutchinson was a leading limnologist and ecologist at Yale University who is considered to have invented modern ecology (Slack 2010). Over his long career, he supervised a large number of graduate students who in turn also became leading ecologists. These included Gordon Riley, Edward Deevey, Peter Wangersky, Ian McLaren, Eric Mills and Roger Doyle who all subsequently joined the faculty of Dalhousie University. They in turn supervised numerous graduate students who were later recruited into MEL by Lloyd Dickie. These included Bob Conover, Doug Sameoto, Don Gordon, Steve Kerr, Gareth Harding and Paul Brodie. While not a student of Hutchinson, Lloyd undoubtedly came under his influence while doing his masters degree at Yale. By the early 1970s, the greatest number of branches on the Hutchison family tree had sprouted in Halifax/Dartmouth (Kohn 1971).

University Ties

Over the years, MEL nurtured and benefited from close ties with universities, in particular Dalhousie but also others including Acadia, University of Toronto, McGill, Rimouski and Memorial. Quite often staff had joint appointments and taught and supervised graduate students. They also served on graduate committees and as external examiners at thesis defenses. In some cases, they procured funding from NSERC to support graduate students.

International Involvement

Many MEL staff were key members of committees and working groups of numerous international marine science organizations such as the Scientific Committee on Oceanographic Research (SCOR), the International Oceanographic Commission (IOC), the International Council for the Exploration of the Sea (ICES) and the International Geosphere and Biosphere Program (IGBP). The latter included the Joint Global Ocean Flux Study (JGOFS) and Land Ocean Interactions on the Coastal Zone (LOICZ) programs. Staff were also members of numerous professional societies such as the American Society of Limnology and Oceanography (ASLO), the Estuarine Research Federation (ERF) and the American Fisheries Society (AFS) and as such often served as officers and helped plan major international conferences. While travel had to be approved by Ottawa, most staff were able to attend several scientific conferences of their choice every year. They also served by invitation on numerous international review committees as well as panels of various granting agencies such as the National Scientific and Engineering Research Council (NSERC), the US National Science Foundation (NSF) and the US Office of Naval Research (ONR). Staff also devoted considerable effort to reviewing manuscripts for international scientific journals. As a result of these combined activities, MEL scientists were very much a part of the international marine science community which helped to ensure that research programs were relevant and on track.

It was possible for staff to apply for professional development leave as long as it was consistent and beneficial to their work, and many did. Some undertook part time graduate student programs at universities to earn advanced degrees while others spent up to a year away from BIO working in overseas marine labs. These included the Scottish Marine Institute in Oban, Scotland, the Institute for Marine Environmental Research in Plymouth, England, the Netherlands Institute of Sea Research on Texel, Netherlands, the International Atomic Energy Agency in Monaco and the Observatoire Oceanologique de Villefranche in Villefranche, France. These extended visits provided the opportunity to interact with other scientists, learn about related research programs in other countries and learn new methods.

Visitors

Over the years MEL attracted a large number of visitors from all over the world to work with its scientists and make use of the excellent BIO facilities. Many of these were younger investigators and this experience had a major influence on the direction of their subsequent careers. Some visits were short to learn about current research programs, obtain information on new instrumentation or participate in research cruises. Other visitors stayed for longer periods and contributed to research projects. Some worked on contract while others came on sabbaticals. Numerous postdoctoral fellows stayed for periods of one or two years. When funding was available, a large number of summer students were employed. Other visitors included graduate students from universities who were being supervised by MEL staff. Quite a few of these students and PDFs were eventually hired into full time positions and examples include Dan Ware, Nick Prouse, Peter Schwinghamer and Peter Cranford. There were also frequent visits from the media to gather information for interesting stories. The long list of well-known scientific visitors includes Jacques Cousteau and David Suzuki.

Major Scientific Accomplishments

Many of the MEL accomplishments over its twenty-two year existence are summarized in the BIO annual reviews and articles in *Voyage of Discovery* (Nettleship et al. 2014), the commemorative book celebrating the 50th anniversary of BIO. These include extensive lists of publications including scientific journals, technical reports, symposium proceedings and books. A searchable data basis of all BIO publications has been prepared by Library staff and is available on line at:

https://inter-j01.dfo-mpo.gc.ca/spb/staffpublications/index?lang=en

Below is a summary of some of the highlights of MEL research, both during the twenty-two years it existed and continued by its scientists under the new organizational structure after the demise of the lab in 1987.

New sampling tools

Quite often the tools for sampling marine ecosystems in support of MEL programs were not available off the shelf but had to be designed and fabricated in house with the assistance of BIO mechanical and electronic engineers. As reviewed by Murphy (2016-2017), these included various pumping systems, in situ particle counters, the BIONESS zooplankton sampler, various incubation chambers, sediment traps, Videograb, Campod and the ECOLOG acoustic fish detection system. Many of these were copied by other laboratories and some were transferred to industry for manufacturing and sale.

Plankton

MEL was perhaps best known for the many fundamental contributions to understanding marine plankton made by the Biological Oceanography Division (Li 2014). These included determining many of the major factors controlling primary production by phytoplankton, discovering the great importance of picoplankton in the transformation of energy in the sea, unravelling many of the details of secondary production by zooplankton and assessing the ecological geography of the world ocean. Field studies ranged from local waters to the global ocean, including working under ice in the Arctic Ocean.

Benthos

MEL also made important contributions to benthic ecology (Gordon et al. 2014b). These included determining the primary production of seaweeds, benthic algae and saltmarshes in local coastal environments. The composition of benthic communities, and in some cases secondary production, were determined in numerous locations ranging from the intertidal zone to the continental shelf. Benthic studies addressed a broad range of organisms including bacteria, meiofauna, macrofauna, epifauna and large charismic species such as deep-water corals. The combined results contributed to the broader BIO-wide program of seabed habitat mapping.

Non-living organic carbon

A wide variety of projects were carried out on the properties and dynamics of the huge reservoir of non-living organic carbon in the sea, including both dissolved and particular components. These included determining the concentrations and vertical profiles in the Atlantic, Pacific and Arctic oceans, studying the transformation processes between dissolved and particulate forms, investigating sedimentation rates and pelagic and benthic exchanges and exploring its role as a food source for marine organisms.

Fisheries

While not directly engaged in providing advice for the management of fisheries, many fundamental studies were conducted that addressed larval studies of both finfish and invertebrates, recruitment and population dynamics. In addition, MEL investigated the effects of environmental factors, including freshwater runoff and seawater temperature, on fisheries.

Whole ecosystem studies

MEL was one of the first laboratories in the world to conduct whole ecosystem studies in which all major components were investigated ranging from physics to fish and emphasis was placed on understanding the interactions between different trophic levels. These were truly multidisciplinary studies that could only be done at an institute like BIO. The first such study was carried out in St. Margaret's Bay. Soon after similar studies were undertaken in Halifax Harbour/Bedford Basin and Petpeswick Inlet. These in turn were followed by

much more detailed studies in St. Georges's Bay (Lambert et al. 2014) and the upper reaches of the Bay of Fundy (Gordon et al. 2014c). These initial studies were in coastal areas with well-defined boundaries, but later studies expanded to offshore areas such as Browns Bank and the Grand Banks.

Biomass spectrum theory

Beginning with measurements of the size distribution of particles in surface waters on the Hudson-70 Expedition and later calculations of the biomass of zooplankton, fish and mammals from the scientific literature, MEL scientists observed that, to a first approximation, when plotted on a logarithmic scale there was roughly an equal concentration of pelagic biomass over the whole size range from bacteria to whales. This unexpected observation led to the development of the biomass spectrum theory, another unique MEL contribution to understanding marine ecosystems in the world ocean (Duplisea et al. 2014). Given information on the abundance and size distribution of plankton, the theory could predict the equilibrium biomass of fish that a body of water can support. This size-structured view of marine ecosystems has provided an effective theoretical and empirical basis for understanding and managing aquatic ecosystems.

Ecosystem models

Using information from field studies and gleaned from the scientific literature, MEL undertook several projects to develop detailed quantitative numerical models describing the flow of energy through ecosystems of particular interest. These projects included scientists from all oceanographic disciplines and much of the work was done in a workshop environment, often involving international collaborators. One project developed a model of the pelagic ecosystem on the Grand Banks in order to better understand the potential impacts of a major oil spill at the Hibernia development site. Another project developed a model of the Cumberland Basin pelagic and benthic ecosystem in the upper reaches of the Bay of Fundy which was a site under consideration for tidal power development. These models could be used to run simulations to predict the ecosystem impacts of changing important physical and chemical properties. Another numerical model was developed later to predict the impacts of operational hydrocarbon drilling wastes released from offshore platforms on the growth of scallops at any location on the continental shelf.

Marine contaminants

MEL made many major contributions to understanding the distribution, pathways and effects of chemical contaminants on marine ecosystems. Considerable emphasis was devoted to chlorinated hydrocarbons, including DDT (and its derivatives) and PCBs (Addison et al. 2014). Transfer pathways and bioaccumulation in marine food webs were measured in different regions including St. Georges Bay, Sable Island and the Arctic Ocean. In addition, major contributions were made to understanding the fate and effect of oil spills, especially in cold water environments (Gordon et al. 2014c). Later the

hydrocarbon work expanded to include the impacts of operational drilling wastes and produced water routinely released from offshore platforms.

Habitat disturbance

As well as studying the impacts of contaminants, MEL scientists also studied the effects of physical habitat disturbance on marine ecosystems. These included studies of the impacts of causeway construction at various locations as well as the proposed construction of barrages for tidal power development in the Bay of Fundy (Gordon et al. 2014d). In collaboration with other labs, considerable effort was devoted to conducting a series of detailed controlled experiments examining the effects of otter trawling and hydraulic clam dredging on continental shelf benthic habitats and communities (Gordon and Kenchington 2014). In addition, considerable effort was expended to elucidate the environmental effects of salmon and mussel aquaculture (Hargrave et al. 2014).

Monitoring programs

In 1950, the Atlantic Oceanographic Group (AOG) had 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. However, when MEL first began, there was limited appreciation at BIO of the importance of monitoring programs in ecological research, despite the pronounced ecosystem variability observed in European waters for many years by ICES programs. However, this view soon changed. The long-term ecological monitoring program at BIO was established in Bedford Basin where a number of physical, chemical and biological variables were sampled on a weekly basis. This was followed by establishing the Atlantic Zone Monitoring Program (AZMP) which involves participants from other labs and has been sampling a large number of physical, chemical and biological variables along a series of sections across the continental shelf off Atlantic Canada (Li 2014). Both programs continue today but AZMP is negatively affected by the unreliability of ship time.

International science

Over the years, MEL scientists played an active role in international organizations and programs. Organizations included the International Council for the Exploration of the Sea (ICES), the Scientific Committee on Ocean Research (SCOR), the International Oceanographic Commission (IOC), the International Geosphere Biosphere Program (IGBP), the Gulf of Maine Council on the Marine Environment and the Regional Association for Research on the Gulf of Maine (RARGOM). Projects included the Joint Global Ocean Flux Study (JGOFS), Land Ocean Interactions in the Coastal Zone (LOICZ), Global Ocean Ecosystem Dynamics (GLOBEC) and Mussel Watch. These activities including participating in working groups and workshops, helping to organize conferences and drafting documents.

Provision of scientific advice

As civil servants, MEL scientists always recognized the importance of providing scientific advice on ecosystem issues as requested to a wide range of clients both within and outside government. Over the years, this consumed a considerable effort which was not always apparent to those not involved. This demand generally increased with time as the need for ecological information in making sound management decisions became better recognized. In the early days of MEL, the provision of advice was done informally on a one on one basis, usually over the phone or at meetings. However, later this was done through the formal mechanisms established by DFO at BIO. Written documents were often prepared and peer reviewed. Internal DFO clients included fisheries managers and later expanded to include habitat and ocean managers. External clients included other federal departments, provincial and municipal governments, non-government organizations and various industries including consulting, oil and gas, fishing and tidal power. Much of this advisory work addressed the need to assess the environmental impacts of a wide range of development projects as well as the need to assist in the design of efficient and sound environmental monitoring projects which industry was required to carry out. Considerable time was spent in committee work and reviewing environmental impact assessments prepared by consultants for industry. In addition, advice was provided on the design of marine protected areas and other closures to protect valuable and vulnerable habitat and organisms.

Reasons for Closure

If MEL was so successful and highly respected in the international marine scientific community, why was it disbanded by Ottawa in 1987? One important contributing factor was the mindset of senior managers in Ottawa at the time. In early days of oceanographic and fisheries research in Canada, senior managers in Ottawa were primarily scientists who had come up through the ranks from the regions. Examples include Alfred Needler, Ron Hayes, Neil Campbell, Art Collin, Gerry Ewing and Art May. They had been directly involved in research and many had gone to sea. Therefore they had first hand experience of how marine research was conducted and should be managed. This changed later as many new senior managers had either no or limited research experience and tried to run federal science programs like other government operations. This shift from having managers with a scientific background to generalists was everywhere in the government in the 1980s and 1990s, not just DFO. However, it certainly was remarkable in DFO, starting with the DM, then the ADMs and down the ranks. As a result, there were fewer knowledgeable people in Ottawa to manage DFO research activities.

Over the years, there had been a progressive trend of undermining the authority of regional science directors and exerting greater control from Ottawa. The initial step in the demise of MEL was the termination of Ocean Science and

Surveys (OSS) and merging it with the Fisheries Resource Branch. As well as MEL, OSS had contained all the DFO programs in hydrography, physical oceanography, chemical oceanography and ocean engineering in three regions across the country, Maritimes, Quebec and Pacific. This move effectively ended the long history of the Canadian federal oceanographic community having a direct voice around the decision-making table in Ottawa. Reading between the lines, it seems that senior DFO managers in Ottawa, dominated by fisheries people, wanted to rein in OSS programs and have more control on how they used their resources. This translated into more focus on applied research dealing with local and immediate issues.

With the demise of OSS, MEL was especially vulnerable. It was the only lab of its kind in Canada and its fate was inevitable. Despite its international reputation for scientific excellence, senior managers in Ottawa did not fully appreciate the importance and value of MEL research to the long-term objectives of DFO and saw no compelling reason to maintain it. As a result of extended jurisdiction in 1977, they were preoccupied with the new responsibility of managing the extensive fisheries on the Canadian continental shelf that had been previously managed by ICNAF. They felt that Ottawa should determine the fields of study of most benefit to Canadians and that scientists in turn should plan research programs to meet these needs, with milestones of achievement against which progress could be measured. There also was the desire to have the same organizational structure in each DFO region across the country. The decision to disband MEL was made in Ottawa by senior managers who had no appreciation of what they were destroying. They wanted to close MEL and assimilate its expertise and resources into the new nation-wide DFO science organization. This decision was not based on science or MEL not living up to its mandate. The fate of MEL would probably not have been any different if it had elected to join the Fisheries Resource Branch in 1976 instead of OAS.

During the period of 1983 to 1989, John Leefe was the Nova Scotia Minister of Fisheries. As well as overseeing the major reorganization of DFO and demise of MEL, the senior DFO managers in Ottawa were also dealing with the developing crisis in the Atlantic groundfishery. He found it very difficult working with DFO in Ottawa and his personal perspective on events at the time is well worth reading (Leefe 1995). The Province of Nova Scotia was very critical of DFO fisheries management policies and practices. The Minister, Tom Siddon, would hear provinces out but take little or no action and let DFO staff do what they intended. Nova Scotia recognized that the statistical basis for fisheries management was significantly flawed because of widespread misreporting of weight, species and areas of catch. In a letter to Siddon in October 1986, the province expressed its view that adequate catch data were not available and questioned the integrity of federal harvesting statistics. This was widely reported in the media and Siddon and senior DFO staff in Ottawa were not amused. The province felt that Ottawa never really understood the

true nature of the fishery in the region. However, in 1989, Siddon took some positive action by establishing the Haché Task Force which was tasked to create a new management regime which considered recommendations from industry and provincial fisheries across Atlantic Canada. The final report was highly praised. Emphasis was placed on managing by effort control, closures and trip limits instead of fishing entirely to mythological numbers created by what at best is a most imperfect science. However, these recommendation came too late and were not acted upon. Groundfish stocks were already in a critical state. Had DFO taken earlier action, this situation could have been averted.

Legacy

The demise of MEL represented a turning point in ecological research at BIO. The organizational changes were driven by managers who were more interested in running an efficient federal government department than nurturing a marine ecological research laboratory of international stature. The decisions made represented a passing dark cloud to the marine research community but fortunately most of the MEL staff remained at BIO after the lab was terminated and, while unhappy at first, adapted to the new science organization and carried on their ecological work as best they could.

In addition, the Marine Fish Division (MFD), which had begun some ecosystem level projects soon after it was established in 1976, continued to expand these activities. It was always recognized since the founding of the Fisheries Research Board labs that proper fisheries management required more information than just the internal dynamics of individual fish stocks and that there was a need for ecosystem models proposing plausible hypotheses of ecosystem functioning. These in turn required theoretical developments in ecosystem control, spatial dynamics and habitat-productivity linkages. In addition, the importance of environmental monitoring programs was increasingly recognized. As a result, building upon earlier ecological initiatives, MFD initiated a number of new ecosystem level research projects (O'Boyle et al. 2014).

Another factor which led to the development of new ecological programs at BIO was the passing of the Oceans and Species at Risk acts that required DFO to assume an oceans management mandate. As a result, new projects with an ecological focus in support of management were initiated by an influx of new staff. In addition to research, these included preparing synthesis and status reports, recovery plans for threatened species, developing integrated ocean management plans for large spatial areas and creating marine protected areas. These diverse activities, critically dependent on ecological information, greatly assisted decision-making across a broad spectrum of ocean users (Murphy et al. 2014).

MEL did indeed leave an important legacy. It made important contributions to international scientific knowledge and, along with others, contributed to emphasizing the importance of ecosystem level research in understanding and managing Canadian marine fisheries. Despite the expanding interest in and recognition of the need for oceanographic and ecological research, a number of factors placed substantial limits on what could be accomplished in DFO under the new operating conditions. The introduction of sector management moved essential support facilities out from under the direct control of laboratory directors and increased administrative red tape. Many important decisions were being made by professional managers with no scientific experience. Continuing cuts in A-Base funding and staff were crippling and it proved difficult to replace most of the retiring staff and, as a result, scientific expertise steadily declined. After the arrival of *Needler* in 1982, the once superb fleet of research vessels was allowed to deteriorate. As a result of the funding cuts, scientists had to invest an increasing amount of time into procuring external funding for their research programs. As a result, research became more applied to address the needs of those paying the bills which meant less opportunity to explore promising new research opportunities as MEL had been able to do in its early years. Growing restrictions on travel made it much more difficult for all scientists to participate in international science activities. All these changes de-emphasized the fundamental science that had been a priority of MEL and other DFO research groups.

BIO Today

As stated above, much of the success of MEL was due to the fact that it was wisely located at BIO as part of a major and diverse oceanographic community. It enjoyed a rather distinct scientific culture and morale was high. Staff interacted regularly be it over coffee, meeting in the halls or Library, at seminars or while working in the field. Many spent substantial time together at sea and enjoyed the privilege of getting seasick with their supervisor. They were proud of BIO and felt that their work was appreciated, both at home and abroad. Staff were devoted to their work and many spent extra hours on their research. Upon retirement, many became emeritus scientists and continued to work on projects of their choice. Many became active members of the BIO-Oceans Association.

Today, the culture of BIO is much different. The remaining scientific staff seem much more isolated and the majority appear to spend most of their time sitting in their cubicles working at computers. Coffee groups seem much less common and fewer staff have the opportunity of participating in exciting field programs. In addition, travel to participate in external scientific activities is severely restricted. While staff may have the same enthusiasm in approaching their work as in earlier MEL days, the working environment has drastically changed. Resources are stretched thin and top-down management from Ottawa reduces creativity. Another factor is that the scientific research community is

now just one small part of the BIO campus which now houses all the management and administrative functions of DFO, including the Canadian Coast Guard. As a result, there is a completely different atmosphere when one walks in the front door. It feels more like a government office than a research laboratory. One wonders if the time has come to take the 'oceanography' out of the Bedford Institute of Oceanography to better reflect its current composition and function.

CONCLUSION

The experiment of setting up a dedicated laboratory to investigate the structure and dynamics of marine ecosystems supporting fisheries in the Canadian federal government service was an unqualified success. MEL was a major component of the Bedford Institute of Oceanography (BIO), a multidisciplinary marine laboratory of international stature. At the time it was founded, oceanography was a high priority of the federal government and well funded. BIO possessed all the necessary infrastructure for conducting marine research, including a superb fleet of research vessels. MEL scientists were given a wide range of latitude in planning their programs with a primary focus on basic research. As a result, many fundamental advances were made in understanding the functioning of marine ecosystems, both in Canadian waters and the world ocean. With time, the mandate of MEL expanded to include studying the impacts of human activities on marine ecosystems. Many scientists became leaders in their fields and MEL earned an international reputation for excellence. It was a dynamic and inspiring place to work. Many practical benefits to Canada were accrued from MEL research, including providing scientific advice on environmental emergencies and emerging environmental issues.

During its twenty-two year existence, there was a pronounced change in Canadian federal government science policy and the research environment. There was a gradual trend in Ottawa to take authority away from the directors of the regional research laboratories and assume control of expenditures by means of detailed planning, programming and budgeting (PPB). It was hoped that, by this process, government science could be more focused on practical problems specific to Canada. Exerting more central control, senior managers seemed more interested in operating a business with specific objectives rather then research laboratories contributing to the global understanding of the structure and dynamics of marine ecosystems.

In 1986, there was a major re-organization in the Department of Fisheries and Oceans driven by Ottawa. Up until this time, the oceanographic and fisheries components had been separate with their own assistant deputy ministers but now they were combined under a new Assistant Deputy Minister of Science. The fate of MEL was inevitable. In the eyes of senior managers, it was very

much an anomaly of questionable value and therefore it was terminated despite widespread opposition from the scientific community.

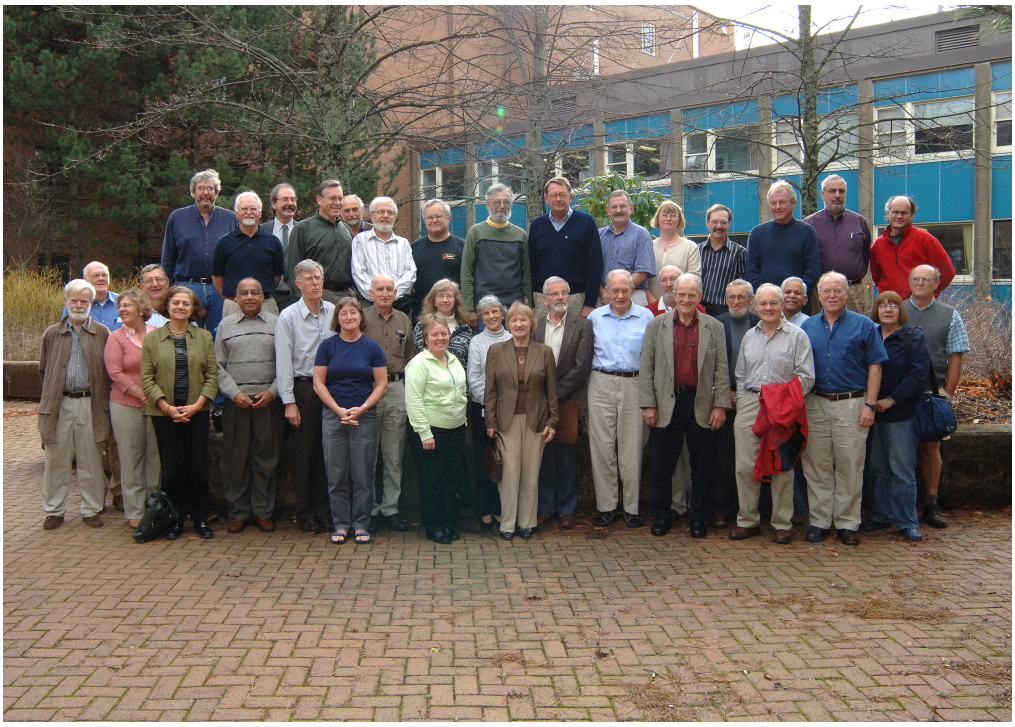
The demise of MEL was indeed a passing dark cloud for Canadian marine science that lasted for several years. In retrospect, this severely disruptive situation could have been avoided if senior DFO management had consulted and listened to MEL staff regarding their opinions on how marine ecological research could be best reorganized and continued under the new science structure and resource limitations. Instead, without any consultation and limited understanding of the situation, they proceeded to break up MEL and distribute its staff to other units, including other DFO regions. It seemed as if their minds were made up from the very beginning and that they were not open to other points of view.

Fortunately, this was not the end of ecological research at BIO. Despite the setback, most MEL scientists remained and once the dust settled were able to carry on many of their previous projects and establish new ones under the new science organization with the full support of local managers. In addition, the government soon realized that there was a pressing need to know more about the functioning of marine ecosystems, not only for application to fisheries management but also for dealing with emerging environmental issues such as climate change. As a result, other DFO units began increasing efforts to add an ecosystem component to their programs. Another factor leading to the development of new ecological programs at BIO was the passing of the Oceans and Species at Risk acts which required DFO to assume an integrated oceans management mandate. This expanded mandate led to the establishment of a whole new suite of projects with ecological themes. The multidisciplinary strengths and team building customs that characterized BIO were instrumental in implementing science-based approaches to the management of oceans, habitat, and species at risk. Despite declining resources and increasing red tape in recent years, this broader program of ecological research at BIO has been quite successful.

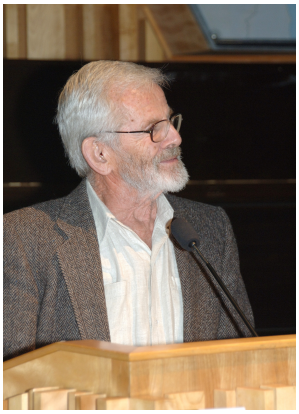
The MEL was a successful organization that thrived because it was at the right place at the right time. At BIO, it operated under exceptional circumstances which provided an exciting and creative research environment, very much like a ‘federal university’ with a soul. As a result, over its twenty-two year history, MEL developed an outstanding international reputation for excellence and made many fundamental contributions to improving our understanding of marine ecosystems and how they can be affected by human activities which have been of great benefit to Canada.

CELEBRATING THE PAST

Almost twenty years later after the demise of MEL, in 2006 thirty-seven ex-MEL staff gathered together for a reunion at BIO which included talks by Peter Beamish, Lloyd Dickie, Tim Lambert, Ken Mann and Don Gordon. A group photo was taken in the central courtyard and banquet held at the Westin Hotel. In preparation of this event, an alumni list with 188 names was prepared.



MEL Reunion, November 2006



Lloyd Dickie

Tim Lambert

Ken Mann

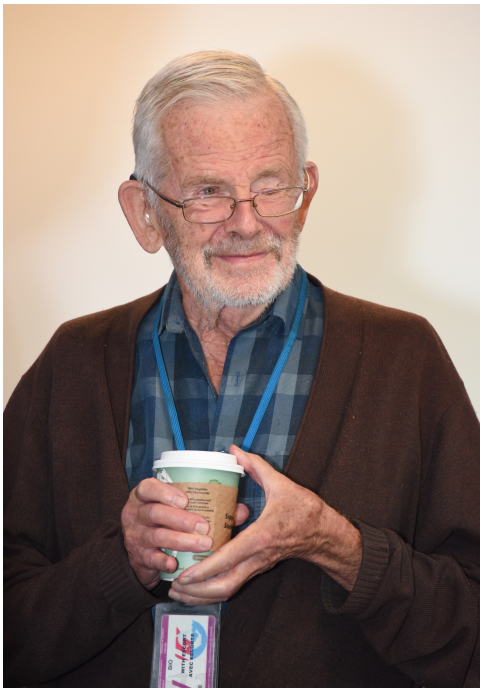
Don Gordon

Glen Harrison, Bob Conover, Shirley Conover

Steve Kerr, Carl Cunningham

Clive Mason, Sue Loring, Doug Loring

In 2015, a group of BIO and Dalhousie scientists gathered to celebrate the 50th anniversary of the arrival of Bill Ford and Lloyd Dickie to BIO and Gordon Riley to Dalhousie. Lloyd was a special guest and was in fine form.



Lloyd Dickie

ACKNOWLEDGEMENTS

A large number of scientific colleagues, including ex-MEL staff, provided invaluable input as this project evolved. I was extremely fortunate to have been able to consult with Lloyd Dickie and Alan Longhurst, two former MEL directors now in their mid-nineties. I was also able to incorporate information from the third director, the late Ken Mann, through his memoirs provided by his family. Eric Mills kindly loaned me his personal files from 1986 and 1987 which contained a gold mine of information on the last days of MEL. Mike Sinclair provided numerous comments from a fisheries research perspective. Numerous suggestions, comments, useful bits of information for incorporation and editorial corrections were provided by Lloyd Dickie, Alan Longhurst, Eric Mills, Mike Sinclair, Barry Hargrave, Tim Lambert, Ken Drinkwater, Paul Boudreau, Richard Addison, Bill Li, Erica Head, Ed Horne, Jim Elliott, Dave McKeown, Brian Petrie, Alain Vezina, Bob Cook, Peter Wells, Ellen Kenchington and Howard Powles. I thank them all for their contributions that contributed immensely to the completeness and accuracy of this story. Kelly Bentham kindly assisted in compiling the photos. And last but not least, I thank Lloyd Dickie for providing me with the opportunity to join MEL in 1970 that changed my life forever.

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APPENDIX 1

MEL STAFF LIST

A listing of when new staff joined MEL, by year, using information from the BIO annual reports and the MEL alumni file compiled in 2006 under the lead of Tim Lambert. Includes permanent staff, term staff and PDFs but not students or contractors. When known, educational background, where they came from and departure dates are included. Their divisions are also identified.

1960

AOG staff moving to Halifax from St. Andrews included:

Neil Campbell (Oceanographer-in-Charge) (PhD)
Ron Trites (PhD UBC)
Art Collin (PhD)
Bill Bailey
F. Forgeron
Roland Chevrier
George Taylor
Carl Cunningham
Malcolm MacLean
Tom Grant
Graham Clarke
Sandra Chandler.

Louie Lauzier and John Hull stayed in St. Andrews. John Lazier (MSc) and Dale Buckley (MSc) were attached for training. Doug Loring (PhD) and Don Peer (MSc) joined AOG soon after the move to Halifax. AOG moved into BIO when it opened in 1962.

1962

R.E. Platford
Paul Cant
B.L. Blackford

1964

Anand Prakash (from UBC) (PhD) Left in 1974
Mark Hodgson (from Dalhousie)
Clarence Bayers (Vessel and Support Services)
T.A. Grant
R.J. Lahey
T.A. Holler

1965

Lloyd Dickie (Director) (from Toronto) (PhD Toronto) Left in 1974, returned in 1978

Martin Blaxland (Executive Assistant)
Sylvia Smith (Admin)
Alma Holland (Admin)
Hilda Gamester (Admin)
S. R. McHughen
Trevor Platt (Biological Oceanography) (MSc Toronto)
Vivian Brawn (Srivastava) (Biological Oceanography) (PhD) Left in 1972
John Bentley (from Reading) (Biological Oceanography)
Ed Kott (Population Dynamics)
Jyri Paloheimo (from Toronto) (Fisheries Oceanography) (PhD) Left in 1967
Brian Fraser (Fisheries Oceanography)

1966

K. Grace (Admin)
Stan Glover (Vessel and Support Services) Left in 1976
Ted Kent (Vessel and Support Services) (*Sigma-T* skipper)
Harry Jarosynski (Vessel and Support Services) (*Sigma-T* deckhand) (later moved to Biological Oceanography)
J.J.G. Major
Brian Irwin (Biological Oceanography)
Bob Conover (from Woods Hole Oceanographic Institution) (Biological Oceanography) (PhD Yale)
Ed Anderson (from Woods Hole Oceanographic Institution) (Biological Oceanography) Left in 1969
Jay Webster (Biological Oceanography)
Iver Duedall (from Oregon State) (Environmental Oceanography) (MSc)
Bob Lively (Environmental Oceanography)
John Smith (from UBC) (Population Dynamics)
Keith Brewer (from Alberta) (Fisheries Oceanography)
John Budlong (Fisheries Oceanography)
Erling Bakken (from Bergen) (Fisheries Oceanography) Left in 1968
Steve Paulowich (Fisheries Oceanography)
Dick Dowd (Fisheries Oceanography)

1967

Ken Overton (Admin)
Marsha Mosher (Admin)
Margaret Frost (from Acadia) (Ellerslie)
Ken Mann (from Reading) (Biological Oceanography) (PhD Reading) Left in 1972, returned in 1980
Bill Sutcliffe (from Lehigh University) (Biological Oceanography) (PhD)
Subba Rao Durvasula (Biological Oceanography) (PhD)

Ray Sheldon (from Pacific Biological Station) (Environmental Oceanography) (PhD)
Ray Rantala (Environmental Oceanography)
Bert Swyers (Environmental Oceanography)
Doug Sameoto (from Queens) (Population Dynamics) (PhD Queens)
Tim Lambert (from Dalhousie) (Population Dynamics) (MSc Dalhousie)
Al MacDonald (from Acadia) (Population Dynamics)
Jim Frost (Population Dynamics)

1968

Lis Clarke (Admin)
Eleanor Hutchinson (Admin)
Chris Sims (Admin)
Jim Matthews (Vessel and Support Services) (*Navicul*a skipper)
Dwayne Richardson (Vessel and Support Services) (*Navicul*a cook and deckhand)
Ralph Savoury (Vessel and Support Services) (*Navicul*a engineer)
Herb MacDougal (Vessel and Support Services) (Fish Lab)
Roy Drinnan (Ellerslie)
Patrick Woo (from Hong Kong) (Ellerslie)
Ken Oatway (Ellerslie)
Madhu Paranjape (from Washington) (Biological Oceanography) (MSc)
Martin Thomas (from Ontario Agricultural College) (Biological Oceanography) (MSc)
Barry Muir (from University of Hawaii) (Population Dynamics) (PhD Toronto) Left in 1975
Elizabeth Alloit (PDF) (Population Dynamics)

1969

Phil Purdy (Vessel and Support Services) (*Sigma-T* deckhand)
Jay Webster (from Western) (Biological Oceanography)
Bob Miller (PDF) (Biological Oceanography)
Mohammed Hassan (from New York) (Environmental Oceanography) (PhD) Left in 1975
Ann Orr (Fisheries Oceanography)
Ken Freeman (Fisheries Oceanography)
Peter Beamish (from UBC) (Fisheries Oceanography) (PhD UBC)
Dave Krauel (Environmental Oceanography) Left in 1975

1970

Harry Buck (Admin)
Faye Bonang (Admin)
Marie Sweet (Admin)

J. Anibie (PDF) (Biological Oceanography)
Don Gordon (from University of Hawaii) (Environmental Quality) (PhD Dalhousie)
Garth Fletcher (from Halifax Fisheries Research Laboratory) (Environmental Quality) (PhD) Left in 1972
Richard Addison (from Halifax Fisheries Research Laboratory) (Environmental Quality) (PhD Belfast)
Steve Kerr (from Dalhousie) (Environmental Quality) (PhD Dalhousie) Left in 1972, returned in 1976
Peter Vass (Environmental Quality)
Doug Willis (from Carleton) (Environmental Quality)
Maurice Zinck (from Halifax Fisheries Research Laboratory) (Environmental Quality) (MSc Dalhousie)
Lorraine (Schnare) Paradis (from Halifax Fisheries Research Laboratory) (Environmental Quality)
Donna Darrow (later Sameoto) (from Halifax Fisheries Research Laboratory) (Environmental Quality)
Dan Ware (from UBC) (PDF and later full time) (Environmental Quality) (PhD UBC) Left in 1982.

1971

Roy Edmonds (Vessel and Support Services) (Fish Lab)
Paul Vandall (Environmental Oceanography)
Barry Hargrave (from Freshwater Biological Laboratory, University of Copenhagen) (Environmental Quality) (PhD UBC)
Paul Keizer (from Dalhousie) (Environmental Quality) (MSc Dalhousie)
Nick Prouse (from Guelph) (Environmental Quality) (MSc Guelph)
Jackie Dale (from Halifax Fisheries Research Laboratory) (Environmental Quality)
Georgina Phillips (Environmental Quality)

1972

Ken Denman (from UBC) (Biological Oceanography) (PhD UBC) Left in 1977
Anitra Laycock (PDF) (Biological Oceanography) Left in 1974
J.-L. Martin (PDF) (Biological Oceanography)
Patrick Mayzaud (PDF) (Biological Oceanography) Left 1975
Serge Poulet (PDF) (Biological Oceanography)
John Wheeler (PDF) (Biological Oceanography) Left in 1973
Gareth Harding (from Dalhousie) (Environmental Quality) (PhD Dalhousie)
Jeff McRuer (Fisheries Oceanography)

1973

Lynn Hume (Admin)

Dick Denman (Vessel and Support Services)
Gordon Rhyno (Vessel and Support Services) (*Navicula* skipper) Left in 1978
Hughie Marryat (Vessel and Support Services) (*Navicula* cook and deckhand)
Terry Rushton (Vessel and Support Services) (Fish Lab)
Paul Dickie (Biological Oceanography)
Trevor Hughes (PDF) (Biological Oceanography)
Alan Jassby (PDF) (Biological Oceanography) Left in 1975
John Vandermeulen (from Duke) (Environmental Quality) (PhD UCLA)
Bill Hardstaff (Environmental Quality)
Paul Brodie (from Dalhousie) (Fisheries Oceanography) (PhD Dalhousie)
Ross Shotton (Fisheries Oceanography) (MSc University College of North Wales)
Maureen Butler (Fisheries Oceanography)
Arlene Diepenbroek (Fisheries Oceanography)
R. MacDonald (Social Science Research)

1974

Marilyn (Baxter) Landry (Biological Oceanography) (Admin)
Ron Duggan (Ellerslie) Left in 1976
Saguro Taguchi (PDF) (Biological Oceanography) Left in 1976
Pat Ahern (Environmental Quality)
Sid Crabtree (Fisheries Oceanography) (PhD) Left in 1975
Berit Henriksen (Fisheries Oceanography) Left in 1978

1975

Brian Petrie (from WHOI) (Environmental Oceanography) (PhD Dalhousie) Moved to Coastal Oceanography in AOL in 1976
Ken Drinkwater (Fisheries Oceanography) (MSc)
Peggy Lehman (PDF) (Biological Oceanography) Left in 1977
Peter Neame (PDF) (Environmental Quality) Left in 1977

1976

Mary Lewis (Biological Oceanography)
Pat Lindley (Biological Oceanography)

1977

Alan Longhurst (Director) (from the Institute of Marine Environmental Research, Plymouth, UK) (PhD London)
Glen Harrison (from Scripps Institution of Oceanography) (Biological Oceanography) (PhD North Carolina State University)
Glen Cota (Biological Oceanography)
Dwight Reimer (Fisheries Oceanography)

Brenda Coté (PDF) (Fisheries Oceanography)

1978

Charles Gallegos (Biological Oceanography) (PhD)
Les Harris (Biological Oceanography)
Dave Rudderham (Biological Oceanography)
Valerie Evans (Biological Oceanography)
Carol Simmons (Environmental Quality)
Freddie Anderson (PDF) (Environmental Quality)
Leon Cammen (PDF) (Environmental Quality)
Bill Silvert (from Dalhousie) (Fisheries Oceanography) (PhD Brown)
Liam Petrie (Fisheries Oceanography)
Cynthia Bourbonnaise (Fisheries Oceanography) (join MFD in 1979)

1980

Erica Head (from Leeds, UK) (Biological Oceanography) (PhD University College of North Wales, UK)
Ed Horne (from WHOI) (Biological Oceanography) (PhD Dalhousie)
Bill Li (from WHOI) (Biological Oceanography) (PhD Dalhousie)
Lorraine Allen (Fisheries Oceanography) (Admin)
Peter Cranford (from Dalhousie) (Environmental Quality) (MSc Dalhousie)
Peter Wells (visiting scientist from Environment Canada in affiliation with the University of Toronto) (Environmental Quality) Left in 1983
Scott Abernathy (Environmental Quality) Left in 1983
Chantel Abou Debs (PDF) (Fisheries Oceanography) Left in 1983

1981

Einar Larsen (Biological Oceanography)
Carla Caverhill (Biological Oceanography)
Azmeralda Foda (Environmental Quality)
Rong Wang (PDF) (Biological Oceanography)
Ralph Smith (PDF) (Biological Oceanography)
John Cullen (PDF) (Biological Oceanography)
John Wrench (PDF) (Environmental Quality) (PhD)
Chris Hawkins (PDF) (from McGill) (Environmental Quality)

1982

Peter Schwinghamer (PDF and later full time) (from Dalhousie) (Environmental Quality) (PhD Dalhousie)
Paul Boudreau (Fisheries Oceanography) (MSc)
Steve Bates (PDF) (Biological Oceanography)

1983

Paul Kepkay (from Dalhousie) (Environmental Quality) (PhD Dalhousie)

1984

Ken Frank (from McGill) (Fisheries Oceanography) (PhD McGill)
Jeff Anning (from Burlington) (Biological Oceanography)
Nelson Watson (from Burlington) (Biological Oceanography) (PhD)
Linda Payzant (Biological Oceanography)

1985

Andre Mallet (PDF) (Fisheries Oceanography)
Alain Vezina (PDF) (Biological Oceanography) Left in 1987 but returned in 1999

1986

Chris Taggart (PDF) (from McGill) (Fisheries Oceanography)

Additional MEL staff for which there are no arrival dates:

Paul MacPherson (Biological Oceanography)
Jeff Spry (Biological Oceanography)

APPENDIX 2

MEL PROGRAM

A listing of projects and principle investigators by division as documented in the BIO annual reports. It provides an overview of the evolution of the MEL program over its twenty-two year history.

1965

Environmental Oceanography (Trites)

- Physical oceanography of the southern Gulf of St. Lawrence (Blackford and Trites)
- Laboratory models of circulation (Blackford)
- Physical oceanography of the Margaree estuary (Trites)
- Physical oceanography of Pictou Harbour and approaches (Trites)
- Solubility product of calcium carbonate in sea water (MacIntyre and Platford)
- Activity coefficients in sea water (Platford and Dafoe)
- Geology and geochemistry of the Gulf of St. Lawrence (Loring)
- Geochemistry of recent sediments from the St. Lawrence River and Estuary (Loring)
- Oblique echo sounder survey of the shelf around the Magdalen Islands (Loring)

Biological Oceanography (Prakash)

- Effects of food and temperature on the relation between metabolism and body size (Paloheimo and Dickie)
- Relations among food, body-size and growth efficiency in fishes (Paloheimo and Dickie)
- Red blood cell parameters as indicators of metabolic level of fish (Kott)
- Fish physiology and behaviour (Brawn)
- Physiology and ecology of marine dinoflagellates (Prakash)
- Frozen sea water and water quality (Prakash and Hodgson)
- Heterogeneity among commercial samples of fish populations (Dickie and Paloheimo)
- Schooling in predator-prey relations (Paloheimo and Dickie)
- Benthic communities of the Magdalen Shallows (Peer)
- Northumberland Strait causeway area benthic fauna (Peer)

1966

Environmental Oceanography (Trites)

- Physical oceanography of Margaree Harbour (Trites)
- Physical oceanography of St. Margarets Bay (Trites)
- Physical oceanography of Cabot Strait (Trites)
- Seawater chemistry (Platford and Duedall)

- Geological and geochemical investigations of marine sediments in the Gulf of St. Lawrence (Loring)

Biological Oceanography (Conover)

- Researches in primary production (Platt)
- Physiological ecology of marine dinoflagellates (Prakash)
- Other dinoflagellate studies (Prakash and Hodgson)
- Oxygen utlization and nitrogen excretion in relation to life cycles and production cycles in marine zooplankton (Conover)
- Benthic communities – Gulf of St. Lawrence (Peer)
- Biochemical ecology (Kott)

Fisheries Oceanography (Paloheimo)

- Fish physiology and behaviour (Brawn)
- Fish populations (Bakken)
- Fish distributions and fishing success (Paloheimo)
- Digital echo-counting system (Paulowich, Dowd, Budlong)

1968

Environmental Oceanography (Trites)

- General studies in physical oceanography (Trites)
- Physical oceanographic studies in St. Margarets Bay (Trites)
- Physical oceanography of Margaree Estuary (Krauel)
- Seawater chemistry (Duedall)
- Geological investigations of the Gulf of St. Lawrence (Loring)
- Occurrence and significance of iron, manganese and titanium in sediments from the estuary of the St. Lawrence River (Loring)
- Organic carbon in marine sediments of the Gulf of St Lawrence (Loring)

Biological Oceanography (Mann)

- Productivity studies in St Margaret's Bay (Mann)
- Primary and secondary productivity studies in St. Margaret's Bay (Platt)
- Studies of plankton distributions (Platt)
- Integrating photometer (Platt)
- Productivity of the seaweed zone (Mann)
- Influence of humic substances on phytoplankton growth (Prakash)
- Factors influencing dark assimilation of C^{14} by marine phytoplankton (Prakash and Sutcliffe)
- *Pyrodinium* blooms (Prakash)
- Bedford Basin studies (Hodgson and Prakash)
- Formation of organic particles in sea water (Sheldon)
- Photosynthesis and respiration of diatoms and dinoflagellates (Durvasula)
- Zooplankton abundance and distribution (Conover)
- Productivity and biomass estimates for zooplankton (Sutcliffe)

- Sediment and benthos survey of St. Margarets Bay (Peer)
- Pictou Harbour benthic samples (Peer)
- Shrimp-sediment relationships (Sheldon)
- Life histories and production of polychaetes in St. Margaret's Bay (Bentley)
- Caloric content of St. Margaret's Bay benthos and zooplankton (Srivastava)
- Production of icthyoplankton in marine fish populations (Sameoto)
- Fish population studies in St. Margaret's Bay (Bakken)
- Food of American plaice (Ardill)
- Benthos of Ostrea Lake, NS (Thomas)

Fisheries Oceanography (Paulowich)

- Acoustic echo-counting (AEC) system for fish populations (Paulowich and Dowd)
- Instrumentation for marine ecology research (Paulowich and Fraser)
- Insitu salinity (conductivity) temperature and pressure measurements (Paulowich and Budlong)

Population Dynamics (Muir)

- The feeding of cod (Srivastava)
- Production and food supply (Paloheimo and Dickie)
- Effects of feeding on metabolism and enzyme activity in fishes (Smith)
- Cardiac regulation in fish (Smith)
- Irrigation of fish gills (Muir)
- Studies of bathypelagic fish (Bakken)

Ellerslie (Drinnan)

- Benthos of Bideford River, PEI (Thomas)
- Problems in production of seed oysters (Drinnan)
- Studies in oyster genetics (Drinnan)

1970

Environmental Oceanography (Trites)

- General studies in physical oceanography (Hassan)
- St. Margaret's Bay and Halifax Harbour (Sharaf El Din, Hassan, Trites)
- Lagrangian measurements (Lauzier, Sharaf El Din, Trites)
- Physical oceanographic studies, Long Harbour, NF (Trites)
- Operation Oil (Trites and Loring)
- Chemical oceanography (Duedall)
- Sediment map of the Gulf of St. Lawrence (Loring)
- Sedimentary environments on the Magdalen Shelf, southern Gulf of St. Lawrence (Loring)
- Physiographic changes in an oyster producing area (Sheldon, Loring, Deleu)
- Heavy metals in the bottom sediments from the Gulf (Loring)
- Trace metal concentrations in shrimp (Loring and Sheldon)

Biological Oceanography (Mann)

- St. Margaret's Bay – Primary production (Platt)
- Studies of plankton distribution (Platt)
- Primary productivity and nutrients in Bedford Basin (Platt)
- Influence of humic compounds on phytoplankton growth (Prakash)
- Dark assimilation of $^{14}CO2$ (Prakash and Sutcliffe)
- Pollution-induced eutrophication (Freeman and Prakash)
- Studies of particulate material in suspension in the sea (Sutcliffe, Sheldon and Prakash)
- Productivity of the seaweed zone (Mann)
- Zooplankton studies (Sutcliffe)
- Pteropod biology (Conover)
- Distribution and physiology of zooplankton in the South Atlantic and South Pacific (Conover and Paranjape)
- Sea urchin grazing rates and productivity in St. Margarets Bay (Miller)
- Studies on the benthos (Peer)
- Molluscan shellfish studies – eastern Canada (Drinnan)

Population Studies (Muir)

- Analysis of fish growth (Kerr)
- Macrozooplankton and ichthyoplankton studies (Sameoto)
- Mackeral biology study (Muir, MacKay and Lambert)
- St. Margarets Bay fish studies (Mackay and Muir)
- Functional morphology of fish gills (Muir)
- Studies on trophic relationships (Srivastava)
- Studies on American plaice energetics (McKinnon)
- Metabolism and enzyme activity in fishes (Smith)

Fisheries Oceanography (Beamish)

- Marine bio-acoustics (Beamish)
- Echo counting system for demersal fishes (Dowd)
- Design studies for proposed fisheries research vessel (Paulowich)
- Salmon counting (Paulowich)
- Computer selection Paulowich)
- Continuous chlorophyll measurements (Paulowich)

Environmental Quality (Gordon)

- Pesticide studies (Kerr)
- Organochlorine pesticide residues in marine oils (Addison)
- Organochlorine pesticide residues in marine species (Addison and Kerr)
- Phosphorus studies (Fletcher)
- Analyses for elemental phosphorus (Addison)
- Phosphorus deposit survey operations (Addison)
- Phosphorus assimilation by Long Harbour marine life (Addison)
- Hydroxamate studies (Fletcher and Addison)
- Miscellaneous studies (Addison)

1972

Environmental Oceanography (Trites)

- Coastal embayments (Heath and Trites)
- Diffusion studies (Krauel)
- Mesoscale inhomogeneities (Hassan and Trites)
- Remote sensing (Vandall)
- Geochemistry of the major elements in marine sediments from the Gulf of St. Lawrence (Loring)
- Distribution of *Clostridium botulinum* Type E in marine sediments from the Gulf of St. Lawrence (Laycock and Loring)

Biological Oceanography (Platt)

- Phytoplankton productivity and nutrient measurements in coastal inlets (Platt)
- Studies on spatial distribution of phytoplankton (Platt)
- Humic compounds and coastal fertility (Prakash)
- Dialysis culture of marine planktonic algae (Prakash)
- Pollution –induced eutrophication and aquaculture (Freeman and Prakash)
- Productivity of seaweeds and marsh grasses. (Mann)
- Bacterial decomposition of seaweeds (Laycock)
- Aquatic macrophytes as sources of particulate and dissolved organic matter (Laycock and Sutcliffe)
- Particulate transport and nutrient chemical balances in Petpeswick Inlet (Kranck, Sheldon and Sutcliffe)
- Preliminary studies of some coastal processes (Sutcliffe)
- Standing stocks and production rates of particles in the ocean (Sheldon)
- Laboratory models of planktonic food chains (Conover and Poulet)
- Biochemistry and physiological ecology of zooplankton nutrition (Mayzaud)
- St. Margaret's Bay zooplankton and icthyoplankton (Sameoto)
- Gulf of St. Lawrence euphausiid study (Sameoto)
- The food chain leading to lobsters (Mann)
- Energetics of sea urchins (Miller)
- Uptake and metabolism of metals by decapods (Martin)
- Studies on the benthos (Peer)

Fisheries Oceanography (Muir)

- Fish in the Gulf of St. Lawrence (Srivastava)
- Larval and postlarval studies (Srivastava, Ware, Newcombe)
- Energetics of American plaice (Ware and MacKinnon)
- Mackeral biology study (Muir, MacKay, Newcombe, Lambert)
- Southern fish species in St. Margarets Bay and Prospect Bay (MacKay)
- Metabolism and enzyme activity in fishes (Smith)
- Marine mammal energetics (Brodie)
- Marine bio-acoustics (Beamish)

- Acoustic echo counting system for demersal fishes (Dowd)
- High frequency acoustic survey system (Paulowich)
- Bellows differential compressimeter (Duedall and Paulowich)
- Continuous flow fluorometer (Paulowich)
- Food chains and fish production (Dickie)
- The European oyster – *Ostrea edulis* (Drinnan)
- Aquaculture research and development – Cape Breton, NS (Drinnan)

Environmental Quality (Gordon)

- Analysis of hydrocarbons in seawater (Keizer)
- Concentration of oil in marine waters off eastern Canada (Gordon, Keizer, Dale)
- Miscibility of oil in seawater (Gordon, Keizer, Prouse)
- The effects of various oils on marine phytoplankton photosynthesis (Gordon and Prouse)
- The concentration of total mercury in seawater (Gordon and Buckley)
- Distribution of dissolved and particulate organic matter in seawater (Gordon and Prouse)
- Pesticide studies (Kerr, Vass)
- Organochlorine residues in seals (Addison and Kerr)
- DDT transport and metabolism (Addison and Darrow)
- PCB studies (Addison, Zinck, Willis)
- Gulf plankton studies: PCB contamination (Ware and Addison)
- Phosphorus studies (Addison)
- Hydroxamic acids (Addison)
- Mine waste water surveys (Addison)
- Pelagic and benthic carbon budgets (Hargrave)
- Substrate-surface area interactions (Hargrave)
- Sublethal effects of pollutants (Hargrave and Newcombe)

1974

Environmental Oceanography (Trites)

- Environment-ecosystem interactions (Loucks, Drinkwater, Krauel, Trites, Hassan, Vandall)
- Geological and geochemical studies of marine sediments (Loring)

Biological Oceanography (Platt)

- Phytoplankton ecology and physiology (Platt, Denman, Therriault, Jassby, Conover, Durvasula, Irwin, Maranda, Taguchi)
- Zooplankton ecology and physiology (Sameoto, Conover, Mayzaud, Poulet, Knipps, Lane)
- Studies of particulate matter (Sheldon, Conover, Paranjape)
- Studies in the benthos (Peer)
- Offshore studies (Sutcliffe, Platt, Durvasula, Sameoto)
- Marine bio-acoustics (Beamish)
- Fish metabolism (Smith)

Environmental Quality (Gordon)

- Development of sampling and analytical methods (Gordon, Keizer, Sutcliffe, Addison, Hargrave)
- Behaviour of pollutants in the environment (Hargrave, Phillips, Gordon, Keizer, Prouse)
- Quantity and distribution of pollutants and naturally-occurring compounds in marine ecosystems (Gordon, Keizer, Dale, Hargrave, Phillips, Ware, Addison, Sameoto, Darrow, Brodie, Thomas, Vandermeulen)
- Laboratory studies of uptake, distribution, metabolism and clearance of pollutants (Harding, Darrow, Vass, Addison, Zinck, Willis, Vandermeulen, Fong)
- Sublethal effects of pollutants (Prouse, Gordon, Vandermeulen, Hargrave, Fong and Phinney)
- Cycling of organic carbon in ecosystems (Hargrave and Phillips)
- Miscellaneous projects (Addison, Harding, Gordon)

Fisheries Oceanography (Muir)

- Larval fish studies (Ware and Lambert)
- Hydro-acoustic assessment of fish stocks (Dowd, Ware, Shotton)
- Instrumentation development (Paulowich)
- Bio-energetic studies (Brodie and Ware)
- Coastal resources and aquaculture (Freeman, Drinnan)

1976

Biological Oceanography (Platt)

- Ecology and physiology of phytoplankton, zooplankton and fish (Platt, Denman, Durvasula, Conover, Mayzaud, Paranjape, Smith)
- Variability in the plankton and their environment (Platt, Denman, Herman, Vandall, Sameoto, Jaroszynski, Paulowich)
- Cetacean bio-acoustics (Beamish)

Environmental Quality (Gordon)

- Basic ecological studies (Hargrave and Phillips)
- Chlorinated hydrocarbons (Addison, Zinck, Willis, Darrow, Hargrave, Phillips, Harding, Vass)
- Petroleum hydrocarbons (Keizer, Dale, Prouse, Gordon, Vandermeulen, Ahern)
- Distribution of heavy metals in the Gulf of St. Lawrence (Loring, Rantala)
- Other studies (Darrow, Addison, Gordon)

Fisheries Oceanography (Sheldon)

- Hydro-acoustic assessment of fish stock size (Dowd, Shotton)
- Bio-energetics and recruitment in exploited fish populations (Ware, Lambert, McRuer, MacDonald)
- Ecology of larval fish (Ware, Lambert, McRuer)
- Dynamics of fish production systems (Kerr)

- The structure of pelagic ecosystems and the relationships between plankton and fish production (Sheldon and Sutcliffe)
- Mollusc studies (Freeman)
- Flounder studies (Freeman)
- Fish production and its relationship to climatic and oceanographic variation (Sutcliffe)
- Bio-energetics of marine mammals (Brodie)

1978

Biological Oceanography (Platt)

- Ecology and physiology of phytoplankton (Platt, Harrison, Irwin, Durvasula, Smith, Hodgson)
- Zooplankton physiology and distribution (Conover, Mayzuad, Skiver, Paranjape)
- Development of the BIO net and environmental sensing system (BIONESS) (Sameoto)
- The BIONESS and acoustic observations of micronekton (Sameoto)
- Nova Scotia shelf break study (Sameoto)
- Other biological programs using BIONESS (Sameoto)
- Biochemistry and bioacoustics of fish (Smith, Dickie, Beamish)
- Bioenergetic models of particle size distributions (Silvert, Platt)

Environmental Quality (Addison)

- Ecosystem contamination (Loring, Rantala, Vandermeulen, Ahern, Keizer, Dale, Hargrave, Phillips, Prouse, Harding and Vass)
- Sublethal effects of contaminants on organisms (Addison, Darrow, Willis, Zinck, Vandermeulen, Ahern)
- Bay of Fundy project (Peer, Loring, Hargrave, Keizer, Gordon, Dale, Phillips, Prouse)
- Symposium on the recovery of an oiled environment (Vandermeulen and Gordon)

Fisheries Oceanography (Sheldon)

- Population dynamics and ecological theory (Shotton, Dowd, Freeeman, Dickie, Brodie, Addison, Sutcliffe, Sameoto, Sheldon, Ware, Silvert, Kerr)
- Ecological studies of recruitment and year class success (Ware, Henricksen, Trites, Lambert, McRuer, Drinkwater)
- Environmental control of fish population abundance (Sutcliffe, Loucks, Drinkwater, Petrie, Trites, Fournier)
- Ecological studies of inshore fisheries – St. Georges Bay, NS (Drinkwater, Harding, Hargrave, Vass, Lambert, McRuer, Pearre, Prouse, Sheldon, Trites, Ware, Harrison, Petrie)

1981

Biological Oceanography (Platt)

- Primary production processes: phytoplankton physiology and bioenergetics (Platt, Harrison, Smith, Durvasula, Horne, Li)
- Secondary production processes: transformation of organic material in secondary production (Conover, Paranjape, Sameoto, Longhurst, Head)
- Atlantic conshelf ecology: studies of the Scotian Shelf and adjacent regions (Conover, Paranjape, Sameoto, Longhurst, Harding, Hargrave)
- Eastern Arctic ecological studies (Platt, Smith, Conover, Vandermeulen, Loring, Brodie, Sameoto, Paranjape)
- (Drinkwater, Harding, Sheldon, Ware, Lambert, Trites)

Environmental Quality (Addison)

- Sublethal contamination and effects: low level responses and physiological stress (Addison, Vandermeulen, Loring, Smith, Harding, Vass)
- Bay of Fundy ecological studies: macrotidal ecology and environmental modification (Loring, Gordon, Keizer, Hargrave, Peer, Prouse, Walker, Phillips, Hawkins, Schwinghamer)

Fisheries Oceanography (Sheldon)

- Population and trophodynamics: ecological theory and structure of ecosystems (Dickie, Freeman, Smith, Kerr, Silvert, Ware, Sheldon, Brodie)
- Environmental variability effects: climate control of fish population abundance (Trites, Drinkwater, Sutcliffe, Ware, Lawrence)
- Inshore ecology: ecological studies of coastal fisheries (Lambert)

1982

Biological Oceanography (Platt)

- Primary production processes: phytoplankton physiology and bioenergetics (Platt, Harrison, Smith, Durvasula, Horne, Li)
- Secondary production processes: transformation of organic material in secondary production (Conover, Paranjape, Sameoto, Longhurst, Head)
- Atlantic conshelf ecology: studies of the Scotian Shelf and adjacent regions (Conover, Paranjape, Sameoto, Longhurst, Harding, Hargrave)
- Eastern Arctic ecological studies (Platt, Li, Conover, Sameoto, Paranjape)

Environmental Quality (Addison)

- Sublethal contamination and effects: low level responses and physiological stress (Addison, Vandermeulen, Harding, Wrench)
- Bay of Fundy ecological studies: macrotidal ecology and environmental modification (Gordon, Hargrave, Cammen, Peer, Prouse, Cranford, Schwinghamer)
- Deep ocean ecology (Hargrave)

Fisheries Oceanography (Sheldon)

- Population and trophodynamics: ecological theory and structure of ecosystems (Dickie, Freeman, Kerr, Silvert, Ware, Sheldon, Brodie, Abou Debs)

- Environmental variability effects: climate control of fish population abundance (Trites, Sutcliffe, Drinkwater, Ware, Lawrence)
- Inshore ecology: ecological studies of coastal fisheries (Drinkwater, Harding, Sheldon, Ware, Trites, Cote, deMestral, Mann)

1983

Biological Oceanography (Platt)

- Primary production processes (Platt, Harrison, Smith, Durvasula, Horne, Li)
- Secondary production processes (Conover, Paranjape, Sameoto, Longhurst, Head)
- Atlantic conshelf ecology (Conover, Paranjape, Sameoto, Longhurst, Harding, Hargrave)
- Eastern Arctic ecological studies (Platt, Li, Conover, Sameoto, Paranjape)

Environmental Quality (Addison)

- Sublethal contamination and effects (Addison, Vandermeulen, Harding)
- Bay of Fundy ecological studies: macrotidal ecology and environmental modification (Gordon, Hargrave, Cammen, Peer, Prouse, Cranford, Schwinghamer)
- Deep ocean ecology (Hargrave, Kepkay, Harding)

Fisheries Oceanography (Kerr)

- Ecology of fisheries production (Dickie, Freeman, Kerr, Silvert, Sheldon, Brodie, Abou Debs)
- Environmental variability effects: climate control of fish population abundance (Trites, Sutcliffe, Drinkwater, Ware, Lawrence)
- Fisheries recruitment variability (Drinkwater, Harding, Sheldon, Ware, Trites, Lambert, Cote, Schwinghamer, deMestral, Mann)

1984

Biological Oceanography (Platt)

- Primary production processes (Platt, Harrison, Smith, Horne, Li)
- Secondary production processes (Conover, Paranjape, Sameoto, Longhurst, Head)
- Atlantic conshelf ecology (Conover, Paranjape, Sameoto, Longhurst, Harding, Hargrave)
- Eastern Arctic ecological studies (Platt, Li, Conover, Sameoto, Paranjape, Watson)

Environmental Quality (Addison)

- Sublethal contamination and effects (Addison, Vandermeulen, Harding)
- Bay of Fundy ecological studies: macrotidal ecology and environmental modification (Gordon, Hargrave, Cammen, Peer, Prouse, Schwinghamer)
- Deep ocean ecology (Hargrave, Kepkay, Schwinghamer, Gordon)

Fisheries Oceanography (Kerr)

- Ecology of fisheries production (Dickie, Kerr, Silvert, Sheldon, Brodie, Abou Debs)
- Environmental variability effects: climate control of fish population abundance (Trites, Drinkwater, Rowell)
- Fisheries recruitment variability (Drinkwater, Harding, Sheldon, Ware, Trites, Lambert, Schwinghamer, Mann, Frank)

1985

Biological Oceanography (Platt)

- Primary production processes (Platt, Harrison, Smith, Horne, Li, Durvasula)
- Secondary production processes (Conover, Paranjape, Sameoto, Herman, Cochrane, Longhurst, Head)
- Atlantic conshelf ecology (Conover, Paranjape, Longhurst)
- Eastern Arctic ecological studies (Li, Conover, Head, Sameoto, Paranjape, Watson)

Environmental Quality (Hargrave)

- Sublethal contamination and effects (Addison, Vandermeulen, Harding)
- Bay of Fundy ecological studies (Gordon, Hargrave, Cammen, Peer, Prouse, Schwinghamer, Hawkins)
- Deep ocean ecology (Hargrave, Kepkay, Schwinghamer, Gordon, Harding)

Fisheries Oceanography (Gordon)

- Ecology of fisheries production (Dickie, Mallet, Kerr, Waiwood, Silvert, Sheldon, Brodie, Abou Debs)
- Environmental variability effects (Trites, Drinkwater, Rowell, Dawe, Lawrence, Vandermeulen)
- Fisheries recruitment variability (Drinkwater, Harding, Sheldon, Trites, Lambert, Schwinghamer, Mann, Frank, Leggett, Carscadden, Peer, Grant)

1986

Biological Oceanography (Platt)

- Primary production processes (Platt, Harrison, Smith, Horne, Li, Durvasula)
- Secondary production processes (Conover, Paranjape, Sameoto, Herman, Cochrane, Longhurst, Head)
- Atlantic conshelf ecology (Conover, Paranjape, Longhurst)
- Eastern Arctic ecological studies (Li, Conover, Head, Sameoto, Paranjape, Watson)

Environmental Quality (Hargrave)

- Sublethal contamination and effects (Addison, Brodie, Vandermeulen, Harding)
- Bay of Fundy ecological studies (Gordon, Hargrave, Cammen, Peer, Prouse, Schwinghamer, Hawkins)

- Deep ocean ecology (Hargrave, Kepkay, Schwinghamer, Gordon, Harding)
- Grand Banks ecology (Horne, Silvert, Keizer, Drinkwater)

Fisheries Oceanography (Gordon)

- Ecology of fisheries production (Dickie, Mallet, Freeman, Kerr, Waiwood, Silvert, Sheldon, Orr, Brodie, Gordon, Keizer, Schwinghamer)
- Environmental variability effects (Trites, Drinkwater, Petrie, Rowell)
- Fisheries recruitment variability (Drinkwater, Harding, Sheldon, Orr, Lambert, Schwinghamer, Mann, Frank, McRuer, Reimer, Peer, Grant)

APPENDIX 3

MAJOR AWARDS WON BY MEL STAFF

1973
Lloyd Dickie was elected to the Royal Society of Canada.

1980
Kenneth Mann was elected to the Royal Society of Canada.

1981
Trevor Platt was awarded the APICS/Fraser Young Scientist Medal.

1982
Daniel Ware was named the 1982 J.C. Stevenson Lecturer.

1984
Robert Conover, Lloyd Dickie, and *Kenneth Mann* received Citation Classic awards for research publications.
Trevor Platt was awarded the Rosenstiel Award by the University of Miami.

1985
Raymond Sheldon was awarded the degree of Doctor of Science by the University of Manchester.

1986
Kenneth Denman was awarded the President's Prize by the Canadian Meteorological and Oceanographic Society.
William Li was awarded the APICS/Fraser Young Scientist Medal.

1988
Alan Longhurst was elected to the Royal Society of Canada.
Trevor Platt was awarded the Evelyn Hutchinson Award by the American Society of Limnology and Oceanography.
Trevor Platt was the national tour speaker for the Canadian Meteorological and Oceanographic Society.

1990
Trevor Platt was elected to the Royal Society of Canada.

1991
Lloyd Dickie was presented the Oscar Sette Memorial Award by the American Fisheries Society.
Alan Longhurst was awarded the Gold Medal by the Professional Institute of the Public Service of Canada.

1992
Kenneth Frank was named the 1992 J.C. Stevenson Lecturer.
Trevor Platt was awarded the A.G. Huntsman Award.

1994
Kenneth Drinkwater was awarded the François J. Saucier Prize in Applied Oceanography by the Canadian Meteorological and Oceanographic Society.
Kenneth Mann was the first recipient of the A.C. Redfield Lifetime Achievement Award presented by the American Society of Limnology and Oceanography.

1997
Alan Longhurst was awarded the A.C. Redfield Lifetime Achievement Award by the American Society of Limnology and Oceanography.

1998
Trevor Platt was elected to the Fellowship of the Royal Society of London.

2001
Donald Gordon was presented with the Canadian 5NR Science Award to Leaders in Sustainable Development.

2002
Peter Vass won the BIO-OA Beluga Award.

2003
Kenneth Mann was presented with the Gulf of Maine Council Visionary Award for Nova Scotia.

2004
Brian Petrie was awarded the J.P. Tully Medal in Oceanography by the Canadian Meteorological and Oceanographic Society.

2005
Daniel Ware won the Timothy R. Parsons Award.
Jacqueline Dale won the BIO-OA Beluga Award.

2006
Trevor Platt and *Kenneth Denman* won the Timothy R. Parsons Award.

2007
Erica Head was the national tour speaker for the Canadian National Committee for the Scientific Committee for Oceanic Research (SCOR).

2008
Donald Gordon was awarded the Timothy R. Parsons Award.

2010
Brian Petrie was awarded the Timothy R. Parsons Award.

2012
Kenneth Frank was the national tour speaker for the Canadian National Committee for the Scientific Committee for Oceanic Research.
Donald Gordon won the BIO-OA Beluga Award.

2013
Kenneth Frank was elected to the Royal Society of Canada.
Gareth Harding was presented the Gulf of Maine Council Visionary Award.

2014
William Li received the John Martin Award from the Association for the Sciences of Limnology and Oceanography.

2020
Kenneth Frank was presented with the Prix d'Excellence by the International Council for the Exploration of the Sea (ICES).

APPPENDIX 4

BOOKS BY MEL STAFF

Dickie, L.M. and P.R. Boudreau. 2015. Awaking higher consciousness. Inner Traditions, Rochester, VT. 246 p.

Kerr, S.R. and L.M. Dickie. 2001. The biomass spectrum: a predator-prey theory of aquatic production. Columbia University Press, New York, NY.

Longhurst, A.R. 1998. Ecological geography of the sea. Academic Press, San Diego, CA. 398 p.

Longhurst, A.R. 2010. Mismanagement of marine fisheries. Cambridge University Press, Cambridge, UK. 320 p.

Longhurst, A.R. 2015. Doubt and certainty in climate science. Available on line at Climate Etc website. 239 p.

Mann, K.H. 2000. Ecology of coastal waters. Blackwell Science Publications, Oxford, England.

Mann, K.H. and J.R.N. Lazier. 1996. Dynamics of marine ecosystems. Blackwell Science, Cambridge, MA.

Nettleship, D.N., D.C. Gordon, C.F.M. Lewis and M.P. Latremouille (Eds.). 2014. Voyage of Discovey: Fifty Years of Marine Research at Canada's Bedford Institute of Oceanography. BIO-Oceans Association, Dartmouth, NS, Canada. 444 p.

Parsons, T.R., M. Takahashi and B.T. Hargrave. 1977. Biological oceanographic processes. Pergamon Press, Oxford, England.

APPENDIX 5

ECOLOGICAL PROJECTS AT BIO AFTER THE DEMISE OF MEL IN 1987

Despite the demise of the Marine Ecological Laboratory as a separate organizational entity at BIO in 1987, it left a valuable legacy of on-going ecological research at BIO carried on by former staff and augmented by others. The importance of adopting an ecosystem approach in all DFO management responsibilities was now well recognized and wide range of new programs was initiated. The examples listed below illustrate the broad range of research topics, geographic areas and collaborators over a period of twenty-three years up to 2010. Lead scientists are identified. While some projects continued to be primarily basic research in nature, most addressed research of a more applied nature reflecting the increasing influence of Ottawa in controlling the research agenda and the need to address the requirements of new environmental legislation. These projects included developing new tools and methodologies, collecting new ecological data using ships and satellites, building ecological models, data management, processing the extensive environmental data bases which had been accumulated and preparing advisory documents for various clients.

1988

- The application of flow cytometry 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 (Li).
- Using data collected from Canada's three oceans, a biogeographic study of calanoid copepods in high latitudes of the northern hemisphere was conducted (Conover).
- A combination of field and laboratory studies provided new information on copepod feeding behaviour and grazing rates (Head).
- The first application of inverse formalism was made to estimate fluxes in plankton food webs. This inverse method estimated parameters from observations of the state variables (Vézina and Platt).
- A scientific evaluation of the likely environmental impacts of exploratory drilling on the Georges Bank ecosystem was completed for the Gulf of Maine Advisory Committee (Trites, Gordon).
- In response to the PEI molluscan toxin emergency, a five-year expanded regional program on marine phycotoxins was initiated in collaboration with 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 identified the toxin as domoic acid, determined that its source was the diatom *Pseudo-nitzschia multiseries* and investigated the biochemistry, physiology and ecology of toxin production (Stewart 2014). In addition, a phytoplankton monitoring program was

conducted in seven coastal inlets over three years to determine sites that would be unfavourable for shellfish aquaculture due to the presence of toxin-producing species (Stewart, Durvasula, Keizer).

- In response to concerns about the environmental impacts of salmon aquaculture, a new multidisciplinary program was initiated in collaboration with the St. Andrews Biological Station. It employed field studies coupled to ecological modelling techniques to examine the impacts of fish farms in the L'Etang Estuary in southwestern New Brunswick (Wildish, Hargrave, Keizer, Silvert).
- Four BIO scientists became members of the Halifax Harbour Task Force which was created by the province to provide recommendations for designing a regional sewage treatment system. Studies included physical oceanography, morphology and chemical contamination of sediments, benthic communities, trace metals and contaminants in lobsters (Nicholls, Petrie, Fader, Gordon).
- A team of BIO scientists prepared a preliminary report examining how the distribution and productivity of fisheries off Atlantic Canada might be expected to change in response to global warming due increasing levels of carbon dioxide in the atmosphere which are increasing the temperature of seawater (Frank, Perry, Drinkwater, Lear).
- Studies were initiated to explore the effectiveness of spatial and temporal closed areas in the management of the haddock fishery on the Scotian Shelf (Halliday, Fanning, Zwanenburg, Showell).
- A DFO workshop on fish population recruitment was held in St. John's, NF. It included physical and biological oceanographers, fisheries biologists and modellers (Sinclair, Anderson, Rice, Chadwick, Gagne, Ayles, McKone, Ware).

1989

- As part of the international Joint Global Ocean Flux Study (JGOFS) 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 (Platt, Harrison, Longhurst).
- 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 (Harrison).
- BIO organized and hosted the Canadian Continental Shelf Seabed Symposium which reviewed knowledge on the nature and stability of the seabed off the three coasts of Canada. Physical, chemical, and biological aspects were addressed and the proceedings were published as a special issue of Continental Shelf Research (Amos, Gordon).
- Sediment traps deployed from the Canadian Ice Island Program provided the first measurements of vertical particle flux under ice in the Arctic Ocean. Highest rates of sedimentation occurred during August

and September when ice cover was at a seasonal minimum and phytoplankton production was maximum (Hargrave, Vass).

- As part of the national Long Range Transport of Atmospheric Pollutants (LRTAP) 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 (Yeats, Keizer, Watson).
- BIO staff participated in a conference in Portland, ME, that created the Gulf of Maine Council on the Marine Environment (Gordon, Nicholls).

1990

- The abundance and distribution of euphausiids, an important winter food source for silver hake, was investigated on the Scotian Shelf during a cruise of *Dawson* using a Batfish-mounted optical plankton counter, the BIONESS plankton net sampler and multi-frequency acoustics (Sameoto).
- MEL staff began participation in the four-year Ocean Production Enhancement Network (OPEN) program funded by the Natural Sciences and Engineering Research Council (NSERC). This multidisciplinary university/government investigated the factors controlling fish and shellfish growth and reproduction. MEL projects focused on Atlantic cod and scallops (Kerr, Cranford).
- 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 (Brylinsky, Gibson, Gordon).
- An inshore groundfish survey was initiated in the Sydney Bight using *Navicula*. It led to the discovery of an important nursery area for cod in the vicinity of the Bird Islands (Lambert, Wilson).
- A novel program was initiated in collaboration with the Icelandic Whaling Station to study the anatomy of captured large whales (Brodie).

1991

- The *Dynamics of Marine Ecosystems: Biological-Physical Interactions in the Oceans* was published (Mann, Lazier).
- 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. Chlorinated hydrocarbon contaminants were measured in seawater and ice algae, phytoplankton, zooplankton and pelagic and benthic amphipods during a one-year seasonal study in Barrow Strait, NWT. Biomagnification of contaminants in the arctic marine food web was observed (Hargrave, Vass).
- Using grappling gear, the *Alfred Needler* conducted a survey of abandoned ghost nets on Georges Bank and recovered a substantial amount of fishing gear (Harding, Vass).

- New work on the biomass spectrum theory described the well-known overall negative slope which essentially reflected the decline in biomass with increasing body size and which could be derived from fitted allometric parameters. It also further described the periodic lumps in the size spectrum which roughly corresponded to the well-defined groups in a marine ecosystem: phytoplankton, zooplankton, and fish (Boudreau, Dickie).
- At the invitation of Exxon, several BIO scientists visited Prince William Sound, Alaska, to assess the effectiveness of the clean-up program conducted after the 1989 *Exxon Valdez* crude oil spill. Once heavily contaminated shorelines showed few traces of remaining oil (Gordon, Vandermeulen, Wells, Lee).

1992

- As part of the international Joint Global Ocean Flux Study (JGOFS), biologists undertook a trans-Atlantic cruise between Halifax and Morocco aboard *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 (Platt, Harrison, Longhurst).
- While periodic studies had been made in Bedford Basin since the opening of BIO, a formal Bedford Basin Monitoring Program was initiated to record the state of the plankton ecosystem on a sustained basis. Weekly measurements at the Compass Buoy were initiated of selected properties that characterize the physical, chemical, biological and optical environments of the water column (Li, many others).
- In collaboration with LASMO Nova Scotia, a program was begun to study 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 (Gordon, Muschenheim, Milligan, Armsworthy).
- The Georges Bank Research Steering Committee was created to coordinate the many research projects funded by PERD addressing the Georges 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 (Gordon).

1993

- 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. The *Wilfred Templeman* carried out the experimental trawling while the *Parizeau* conducted benthic imaging and sampling before and after trawling. This was the first such large-scale experiment of this nature conducted anywhere in the world (Gordon, Schwinghamer, Gilkinson, Rowell, Prena, McKeown, Bourbonnaise, MacIsaac).

- 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 (Silvert, Hargrave, Keizer).
- Scientists began to participate in Gulfwatch, a long-term chemical contaminant monitoring program in the Gulf of Maine 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 (Harding).
- In collaboration with Engineering and Technical Services, the Videograb was developed. This hydraulically–actuated bucket grab equipped with video cameras was designed to minimize disturbance to the sampling area and to provide the operator the ability of visually selecting the precise sampling area on the seabed, close and open the bucket remotely, and verify that the bucket closed properly prior to recovery. Videograb proved to be an excellent tool for collecting samples of sediment and associated organisms with minimal disturbance and worked well on a wide spectrum of seabed types ranging from mud to gravel (Vass, Chin-Yee, Steeves, Vass).

1994

- Studies of non-living organic matter in seawater demonstrated the importance of dissolved, colloidal and particulate fractions to the secondary production of most bacteria and archaea (Kepkay).
- 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 (GLOBEC) program, a collaborative investigation was undertaken with the Woods Hole Oceanographic Institution and the University of Rhode Island to examine the physical and biological processes affecting the recruitment of important species on Georges Bank (Platt).

- The multidisciplinary research program on the fate and effects of drilling wastes on Georges Bank continued. Closely coordinated field, laboratory and modelling studies addressed the physical oceanography and sedimentology of Georges Bank, the flocculation behaviour of drilling wastes and the sublethal effects of drilling wastes on the sea scallops, the most important commercial species on Georges Bank (Gordon, Cranford, Milligan, Muschenheim).
- 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 (Hargrave, Keizer, Silvert, Wildish).

1995

- The operation of BIO research vessels was taken over by the Canadian Coast Guard. All remaining ships were painted red, including the models near the cafeteria. One positive aspect of this change was the introduction of the lay-day system (one month on duty followed by one month off) which made working conditions for the crews much more pleasant.
- A three-week cruise aboard *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 (Platt).
- Algorithms were developed to effectively utilize satellite ocean colour data to estimate phytoplankton primary productivity and the first reliable estimates of global marine production were obtained (Sathyendranath, Longhurst. Caverhill, Platt).
- In cooperation with the Hibernia Management and Development Corporation, a multiyear program was initiated to monitor the fate and effects of drilling wastes released from the Hibernia production platform on the Grand Banks (Gordon, Milligan, Cranford, Muschenheim).
- 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 oceanographic zones on Georges Bank (Hannah, Loder, Milligan, Muschenheim, Cranford, Gordon).
- A global typology of the biological seascape was produced using data on pelagic production and consumption (Longhurst).
- In collaboration with Engineering and Technical Services, Campod was developed. It was designed as a light-weight instrumented tripod equipped with video and still cameras that used the same laboratory controls, slip rings, winch, cable, and block as Videograb. Campod

proved to be an excellent tool for obtaining high-resolution video and photographic imagery of benthic habitat and epibenthic organisms over any kind of seabed regardless of relief, including steep walls of submarine canyons (Vass, Chin-Yee, Steeves).

- The international LOICZ biochemical modelling guideline workshop was held at BIO and drafted a report (Gordon, Boudreau, Mann, Silvert)

1996

- Studies on Georges Bank using Octoprobe demonstrated the importance of turbulence in driving primary production by phytoplankton (Horne, Loder, Naime, Oakey).
- A four-year Canadian program was initiated under the umbrella of Global Ocean Ecosystems Dynamics (GLOBEC), 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.
- 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 Georges, Brown's and German Banks and inshore southwest Nova Scotia (Harding, Pringle).
- 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 (Hargrave, Silvert).
- Various studies were carried out over several years on the interactions between grey seals and Atlantic cod. The importance of grey seal predation on cod mortality was somewhat ambiguous but in the end it was concluded that predation by seals may explain the high natural mortality of cod (O'Boyle, Sinclair).

1997

- Scientists created BioChem, a national archive of marine biological and chemical data collected in the Atlantic region. In 2003, management of this system was taken over by the Marine Environmental Data Service in Ottawa (Yeats).
- A collaborative field experiment on oil spill bioremediation was initiated in collaboration with agencies in France, UK and the Netherlands (Lee).

- 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 (Lee).
- 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. The *Wilfred Templeman* and *Telost* carried out the experimental trawling while benthic imaging and sampling before and after trawling was conducted by the *Parizeau*. This experiment was similar in design to the previous Grand Banks otter trawling experiment but the habitat and communities were much different (Gordon, Schwinghamer, Gilkinson, Kenchington, McKeown, Bourbonnaise, MacIsaac).
- The concentrations of PCBs were measured in different tropic levels of the St. Georges Bay ecosystem. Dramatic biomagnification of PCBs was seen in the upper trophic levels but not in the plankton. This unexpected finding meant that either the cumulative contaminant uptake from feeding by zooplankton was lost by rapid excretion or more probably due to the rapid turnover time of larger zooplankton populations resulting from predation. The overall concentrations of PCBs in biota and declined over a twenty year period (Harding).

1998

- The Atlantic Zone Monitoring Program (AZMP) was implemented in collaboration with the Gulf, Québec and Newfoundland Regions. The aim was to collect and analyze the physical, chemical and biological 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 Georges Bank, including the Gulf of St. Lawrence, for sampling several times a year (Li and many others).
- Numerous oceanographic data sets were analyzed to explore the ecological geography of the sea on a global scale that addressed the fundamental issues of pelagic ecology and biogeography. By placing the typology of seasonal plankton cycles into the context of regional oceanography, characteristic ecological features could be discerned. The results were summarized in a book entitled the *Ecological Geography of the Sea* (Longhurst).
- BIO fisheries biologists collaborated with scientists of the US National Oceanographic and Atmospheric Administration (NOAA) in the East

Coast of North America Strategic Assessment Project (ECNASAP). Using data collected from groundfish trawl surveys in both countries starting in the early 1970s, biogeographic patterns of fish communities and how they have changed over time were identified (Mahon, Zwanenburg).

- 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 on Banquereau. The *Atlantic Pursuit*, a commercial clamming vessel, carried out the experimental dredging while benthic imaging and sampling was conducted before and after dredging by the *Hudson* (Gordon, Kenchington, Gilkinson, Roddick, McKeown, Bourbonnaise, MacIsaac).
- A scientific review of the Gully, a large submarine canyon on the eastern Scotian Shelf under consideration as a Marine Protected Area, was conducted (Harrison, Fenton).

1999

- By measuring *Calanus finmarchicus* egg production rates and animal stage distributions in the Labrador Sea, it was demonstrated that the timing of the spring bloom may have a significant impact on recruitment for the next generation (Head).
- The impacts of scallop fishing on benthic communities was examined by comparing the species composition of epifaunal communities 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 indicated long-term impacts from scallop dredges on larger, more fragile and attached organisms (Kenchington).
- A three-year research program involving university collaborators was initiated in Sydney Harbour to study the ecosystem effects of contaminants released over 100 years of steel and coke production (Vandermeulen, Lee).
- 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 (MPA) (Gordon, Fenton).
- A comprehensive review of the Georges Bank ecosystem and the potential impacts of exploratory drilling was prepared under the Regional Advisory Process. After considering all information, the independent Georges Bank Review Panel recommended that the drilling moratorium be extended until 2012 (Boudreau).
- 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 (Lambert).

2000

- In order to define suitable conservation objectives which could be used to guide an ecosystem approach to ocean management, a national workshop was held at BIO. Objectives were defined to conserve ecosystem biodiversity at the community, population, and species levels, productivity by trophic level and population, and the habitats of the seafloor and water column (O'Boyle).
- An interdepartmental proposal for a national seabed mapping program called SeaMap was prepared. The intent of SeaMap was to map the entire seafloor within Canada's Exclusive Economic Zone off all three coasts using multibeam technology. Planning workshops were subsequently 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 eventually approved by Cabinet, SeaMap was never funded because other priorities (Pickrill, MacDougall, Bradford, Gordon).
- 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 *Hudson* were selected using the results of recent multibeam surveys as well as traditional ecological knowledge (Mortensen, Buhl-Mortensen, Kenchington, Gordon).
- 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 (Hargrave).
- A unique web-based computer working environment called the Virtual Data Center (VDC) was developed. The VDC became the central standard location for a variety of survey data, each with a well-documented set of metadata allowing scientists within and outside DFO to access the survey and fishery data needed for ecological analyses. It also became a location where standardized data extraction and analysis programs are maintained and improved. This centralization of data and software helped to ensure that researchers comparing across spatial zones and across time are drawing conclusions that are related directly to the ecological phenomena being investigated and are not biased by unknown aspects of the data. The VDC has been a valuable component for many ecological analyses.

2001

- A book entitled *The Biomass Spectrum: A Predator-Prey Theory of Aquatic Production* was published which described the biomass spectrum theory. It summarized all the available information on the theory beginning with the empirical data and moving into the theoretical and fisheries applications. It provided a comprehensive overview of all of the various pieces that were necessary to tie the empirical observations to the underlying physiology and trophic relationships to generate a theory of aquatic production on an ecological scale (Kerr and Dickie).
- A three-year study of mussel aquaculture and ecosystem interactions was begun in collaboration with the Maritimes, Gulf and Quebec Regions. Fieldwork 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 (Cranford).
- 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 *Hudson.* The *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 and biological habitat (Gordon, Anderson, Kenchington, Gilkinson, Vass, Reimer, Fader, McKeown, Bourbonnais, MacIsaac).
- Under the lead of the Regional Advisory Process Office and the Oceans and Environment Branch, 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.
- With the collapse of groundfish fisheries, exploratory fisheries had been examined for a wide range of other species such as skates, monkfish, hagfish and blood worms in an attempt to give displaced fishermen new employment opportunities. New assessment procedures were needed for these little known and data-poor stocks. This led to the development of the 'Traffic Light Approach' (TLA) that consisted of tabulating indices of stock recruitment, growth, mortality, and ecosystem trends using a wide range of data sources and without explicitly using a mathematical model to describe relationships among the data. The TLA was seen as a way of not only addressing data-poor stock situations, but also broadening the scope of assessments (Caddy, Halliday, Koeller).

2002

- The biological seascape of phytoplankton in the North Atlantic was examined (Li).
- Analysis of fisheries data from the Scotian Shelf indicated significant changes in species composition since the 1980s, particularly on the eastern half. It was concluded that overfishing was a major driver of these changes but also that environmental variability was a factor as well. Where once the groundfish stocks had dominated the ecosystem, pelagic species such as herring now represented the most abundant fish species (Zwanenburg).
- 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 bottom contacting fishing activities to protect the abundant deep-water corals (Fenton).
- In order to expand knowledge of the distribution of benthic organisms on the continental shelf, an initiative was undertaken to record the invertebrate bycatch in the industry-funded Fisheries Observer Program on commercial fishing vessels which sampled a large area of offshore waters. A species identification guide with colour photos was prepared for use at sea and the data collected were entered into the Virtual Data Centre (VDC) where they were available to researchers. While fishing gear is inefficient at capturing most benthic invertebrates, the results can be used to map the occurrence of large organisms such as corals, sponges, sea cucumbers, sand dollars, sea urchins and starfish.

2003

- A working group prepared the first Ecosystem Status Report in Atlantic Canada which documented the long-term changes in the eastern Scotian Shelf ecosystem for oceans and fisheries managers. It produced 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. It was concluded that there had been a decoupling of benthic and pelagic systems which reduced the energy flow to the benthic system. This decoupling was interpreted as being due to a complex set of factors that were triggered by the cumulative removal of biomass of groundfish species and exacerbated by decadal scale variability in bottom temperature and water column stratification. Cascading impacts of the removal of large fish, in particular the larger cod, were observed. It was hypothesized that the release of predation on mid-trophic level fish caused by overfishing of larger fish led to increases in the relative abundance of small pelagic species such as herring and benthic invertebrates such as snow crab. This in turn was interpreted to have caused decreases in zooplankton abundance and lower predation on phytoplankton resulting in higher

biomass at the base of the food-chain (Frank, Choi, Fisher, Leggett, Petrie, Shackell).

- An ecosystem modelling project on the Scotian Shelf entitled Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic (CDEENA) was initiated with the overall goal to gain a better understanding of the structure and function of eastern Canadian marine ecosystems. Using the trophic dynamic modelling approach called ECOPATH, it was concluded that the systematic removal of larger fish resulted through trophic cascade dynamics in an increase of species in the middle of the food chain. The ecosystem appeared to have changed fundamentally from a 'demersal-feeder-dominated' system to a 'pelagic-feeder-dominated' system (Bundy).
- 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.
- 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 (Mortensen, Buhl-Mortensen, Gordon, Kenchington).
- 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 (Lee).
- 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 (Lee).
- 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 (Lee).
- 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 (Hargrave, Silvert).
- 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 (Lambert).

- 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 (Lee).
- Under the auspices of the Regional Advisory Process and the Oceans and Environment Branch, Phase 2 of the benthic habitat classification project was addressed. A classification approach based on the Southwood model was adopted and applied to the Scotian Shelf. This approach integrated information on geology, physical oceanography and benthic ecology (Arbour, Kostylev).
- Geologists discovered that bottom type determined the spatial distribution of scallops. In general, scallops are found more often on gravel lag which can be easily mapped using multibeam bathymetry. This information was quickly adopted by industry to improve the efficiency of their fishing activities (Kostylev, Todd, Pickrill).

2004

- A conservation milestone was reached in 2004 when the Gully Marine Protected Area (MPA) was established, the first MPA in Atlantic Canada. This MPA protected the largest submarine canyon in eastern North America, an offshore ecosystem recognized nationally and internationally for its features and inhabitants including endangered whales and the highest diversity of coral in Canada. Situated in a complex offshore setting subject to commercial fisheries, shipping, hydrocarbon development, and multinational scientific research, the Gully served as a regulatory prototype (Fenton, Breeze)
- Experiments began with the new oil spill-dispersant wave tank to develop guidelines for the use of oil dispersants (Lee).
- 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 pertusa* reef complex from further damage by bottom-impacting fishing gear (Fenton).

2005

- 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 (Kenchington, Lawton).

- A project entitled Integrated Ecosystem Studies for Modelling Mussel Aquaculture-Environment Interactions was established in collaboration with the Gulf and Quebec regions and Dalhousie University. Modelling combining the results of physical, chemical and biological research addressed broad-scale questions regarding system productive capacity, food depletion, nutrient cycling, and aquaculture/land-use interactions. Field research focused on Tracadie Bay, PEI, the most extensively leased mussel aquaculture embayment in Canada (Cranford, Hargrave, Grant).

2006

- 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 (Li).
- 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, to allow fish migration (Milligan, Law).

2007

- 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 (Lambert).

- In response to a United Nations General Assembly resolution, a new research program was created identify vulnerable marine ecosystems (VMEs) and take steps to protect them from destructive fishing practices. Initial work focused on deep water off Newfoundland under the regulation of NAFO. Through international collaboration, the distribution of gorgonian corals, sea pens, and sponges down to 1,500 m were documented from research vessel bycatch data. Then more detailed information was collected as part of an international research program led by Spain to undertake more detailed research on VMEs in the NAFO regulatory area which utilized multibeam echosounders, seismic acoustics, box corers, rock dredges and CTDs to collect biological, geological, and oceanographic data from the Flemish Cap region. Subsequently, using *Hudson*, surveys using Campod and ROPOS were conducted to depths of 3,000 m. A quantitative method using spatial techniques was devised for identifying significant concentrations of corals and sponges from bycatch data and the results were applied to defining thirteen closure areas in the NAFO regulatory region to protect these organisms. The same methodology was subsequently applied to Canadian waters and identified significant concentrations of corals and sponges from the eastern Canadian arctic to the United States border, including the Gulf of St. Lawrence. This work prompted industry to create a voluntary closure in Emerald Basin to protect a globally unique population of glass-vase sponges. (Kenchington, MacDonald, Cogswell, Beazley, Larette, Best, MacIsaac).
- To operationalize the Longhurst typology for ecological characterisation at local time and place, a computation algorithm based on statistical analysis of geophysical and biological data was developed to delineate irregular dynamic boundaries of provinces in real time. High resolution satellite data on sea-surface temperature and ocean colour were used. With a spatial resolution of 1.5 km, this approach downscaled the seascape towards what might be measured from ships at sea (Devred, Sathyendranath, Platt).
- A theoretical framework was developed that described the sensitivity of benthic habitat as a function of both the level of natural disturbance it experiences and its scope for growth based on production characteristics. This work was used by the Oceans, Habitat and Species at Risk Branch to define sensitive habitats worthy of protection (Kostylev, Hannah).

2008

- A study was conducted of the temporal shifts in the distribution of fish species off Atlantic Canada with an emphasis on species diversity in relation to the North Atlantic Oscillation (NAO). Although the expected bottom temperature response to the oscillations was estimated to be minimal at the latitude of the Scotian Shelf, a 5 to 10% difference in diversity during the three decades in response to NAO fluctuations was observed (Fisher).
- 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 seamount east of Newfoundland (Kenchington).
- In collaboration with Dalhousie University and Nova Scotia Fisheries and Aquaculture, the Program for Aquaculture Regulatory Research (PARR) was established to develop new knowledge to support and advise ecosystem-based environmental regulations and decision making related to aquaculture. This program included a detailed assessment of the environmental impacts of mussel aquaculture in St. Ann's Harbour, NS, the largest mussel lease approved in the Maritimes (Cranford, Grant).

2009

- New studies provided a different perspective on the relative importance of fishing and environmental change on groundfish populations for the northwest Atlantic. The assessment of the 4VsW cod stock determined that, subsequent to the closure of the fishery in 1992, total mortality was still high, implying that natural mortality had remained high. Elevated high natural mortality has also been seen in the Gulf of St. Lawrence and western Scotian Shelf cod stocks. It was concluded that increases in natural mortality of cod began in the late 1980s, contiguous with the collapses of the several cod stocks off Atlantic Canada, and that this phenomenon was widespread. It was also suggested that environmental conditions, at the scale of the Northwest Atlantic, influenced the productivity of groundfish species on decadal time scales. In summary, these analyses concluded that a combination of overfishing and climate variability had been responsible for the observed fluctuations in groundfish population (Halliday and Pinhorn).
- 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 (Wong, Vandermeulen).

- BIO scientists led a third assessment of the Georges Bank drilling issue which 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 (Lee, Cranford).

2010

- Further studies explored evidence of trophic cascades in response to the reduction in abundance of larger fish. It was concluded that top-down impacts due to overfishing of large fish are prevalent and lead to lower species diversity at lower temperatures. In addition, the earlier integrated assessment of the eastern Scotian Shelf was updated and it appeared that the state of the ecosystem may be returning to that observed during the 1980s with fewer pelagic fish and higher abundance of groundfish (Frank, Shackell).
- At the request of the US Environmental Protection Agency, BIO 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 (Lee).
- A book entitled *Mismanagement of Marine Fisheries* was published (Longhurst).
- The spatial and inter-decadal variability in plankton abundance and composition in the Northwest Atlantic from 1958 to 2006 was investigated (Head, Pepin).
- Decline in top predator body size (mainly finfish) and changing climate were shown to alter the trophic structure of the Scotian Shelf ecosystem (Shackell, Frank, Fisher, Petrie, Leggett).