

A LOG OF THE CSS/CCGS *HUDSON* 1963-2022

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Bedford Institute of Oceanography
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Canadian Technical Report of Fisheries and Aquatic Sciences

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Rapport technique canadien des sciences halieutiques et aquatiques

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Dedication

This book is dedicated to three groups of people. First are the federal science managers in Ottawa who had both the vision to create a world-class oceanographic research vessel and the ability to see their ideas through to fruition. Second are the marine architectural firm of Gilmore, German and Milne in Montreal, PQ who designed the new ship and the workers at Saint John Shipbuilding and Drydock Ltd in Saint John, NB who built her. And third are the many officers and crew who operated *Hudson* so efficiently over her long career.

Abstract

Gordon, D.C., Clement, P.M., McKeown, D.L., and Manchester, K. 2025. A Log of the CSS/CCGS *Hudson* 1963-2022. Can. Tech. Rep. Fish. Aquat. Sci. 3681: viii + 235 p. <https://doi.org/10.60825/ys9e-7d51>

The CSS/CCGS *Hudson* was the primary Canadian offshore oceanographic research vessel at the Bedford Institute of Oceanography (BIO) for fifty-nine years until she was retired in 2022. She was designed to be capable of working in all the world's oceans throughout the year with a specific focus on the North Atlantic and adjacent ice-invested arctic waters. *Hudson* was able to comfortably accommodate a large and diverse scientific contingent and conduct oceanographic research programs in the open ocean under most weather conditions. *Hudson's* significant endurance enabled her to travel far and stay at sea for extended periods. From 1963 to 2022 she conducted 495 scientific cruises in the North Atlantic, South Atlantic, Pacific and Arctic Oceans. A description of the vessel is provided followed by year-by-year brief summaries of each individual cruise including details such as area of operation, scientific objectives, equipment used, ports visited and any interesting observations and events. Accompanying each yearly summary is a composite track plot. Also included are listings of the Ship's Masters and Senior Scientists who served on board followed by a complete chronological list of all cruises including year and start date, cruise number, sea days, Captain, Chief Scientist and working area.

Résumé

Gordon, D.C., Clement, P.M., McKeown, D.L., and Manchester, K. 2025. A Log of the CSS/CCGS *Hudson* 1963-2022. Can. Tech. Rep. Fish. Aquat. Sci. 3681: viii + 235 p. <https://doi.org/10.60825/ys9e-7d51>

Le NSC/NGCC *Hudson* a été le principal navire canadien de recherche océanographique en haute mer à l'Institut océanographique de Bedford (IOB) pendant cinquante-neuf ans, jusqu'à sa mise hors service en 2022. Conçu pour opérer dans tous les océans du monde tout au long de l'année, il était particulièrement destiné aux eaux de l'Atlantique Nord et aux zones arctiques adjacentes recouvertes de glace. Le *Hudson* pouvait accueillir confortablement un large contingent de scientifiques et mener des programmes de recherche océanographique en haute mer dans la plupart des conditions météorologiques. Son endurance exceptionnelle lui permettait de parcourir de grandes distances et de rester en mer pendant de longues périodes. De 1963 à 2022, il a effectué 495 missions scientifiques dans l'Atlantique Nord, l'Atlantique Sud, le Pacifique et l'Arctique. Une description du navire est d'abord présentée, suivie de résumés annuels de chacune des missions, incluant des détails tels que la zone d'opération, les objectifs scientifiques, l'équipement utilisé, les ports visités ainsi que les observations et événements notables. Chaque résumé annuel est accompagné d'une carte composite des itinéraires parcourus. Sont également inclus la liste des capitaines et des principaux scientifiques ayant servi à bord, ainsi qu'un registre chronologique complet de toutes les missions, précisant l'année et la date de départ, le numéro de mission, le nombre de jours en mer, le capitaine, le scientifique en chef et la zone d'opération.

Introduction

The CSS/CCGS *Hudson* was the primary Canadian offshore oceanographic research vessel at the Bedford Institute of Oceanography (BIO) for fifty-nine years. During her lengthy and unprecedented career, she travelled widely about the world's oceans and enabled the scientists aboard, with the able assistance of her capable officers and crew, to make a huge number of important scientific discoveries about the properties and dynamics of the sea and the underlying sediments and rocks. These discoveries covered all the oceanographic disciplines of ocean engineering, hydrography, geophysics, marine geology, physical oceanography, chemical oceanography, marine ecology, fisheries and marine mammals. In so doing, she helped establish BIO as a major oceanographic institution in the international scientific community, a credit to Canada.

Over her 59-year career, *Hudson* carried out a total of 475 scientific cruises, many of which had multiple legs. The cruise numbers, dates, days at sea, captain, chief scientist and affiliation, areas of operation and general scientific program for each cruise are listed in chronological order in the Appendix. Some of these cruises were led by other government laboratories and universities. "Ship with a Soul" by D. Gordon (Proc NSIS Vol 53, Part 2, pp.195-204) provides a more general historical description of the life of the vessel.

The highlights of *Hudson*'s long career in support of oceanographic research are presented year by year. The captains, number of cruises, days at sea and total nautical miles steamed are summarized for each year of service (1963-2022). In presenting nautical miles steamed, those marked 'Reported' were taken directly from BIO annual reports and should be quite accurate while those marked 'Estimated' were calculated by multiplying days at sea by the value of 159 nautical miles per day at sea which is the mean value calculated from the data for the 21 years that both data sets are available. Plots of the available navigation data, mostly for BIO cruises, are also presented by year. In general, most of the cruises missing navigation data were led by other agencies. While the data are incomplete, the plots nicely illustrate the broad geographic range covered each year by *Hudson*. Also included for each year is information on such things as refits, mishaps, search and rescue operations, equipment upgrades, changes in management and external events which had an impact on *Hudson*'s operations and research programs.

Also presented for each year are brief summaries of each individual cruise. These contain details such as chief scientist and affiliation, cruise number, collaborators, areas of operation, scientific objectives, equipment used, ports visited and any interesting observations and events.

The major sources of information were the cruise reports or other planning documents (e.g. Coast Guard Form B and Form C). These were available for all but 21 cruises (just 4%) and a complete collection is now held in the BIO Library. Other sources included the BIO annual reports and information provided by numerous major users.

Design

Hudson was designed by the firm of Gilmore, German and Milne in Montreal, QC. She was the first Canadian ship designed specifically for hydrographic and multidisciplinary oceanographic research in Canada. She had to be capable of working in the North Atlantic and adjacent ice-invested arctic waters but also in the world's oceans in general.

Hudson had a Lloyd's Ice Class I hull and was certified as Arctic Class 2. Her welded steel construction allowed effective and safe movement in ice-infested waters. She was equipped with a rounded nose stem, a graceful sheer and a contoured cruiser stern which made her a most attractive and seaworthy vessel.



CSS Hudson in dry dock (Credit BIO Photo Unit)

Her vital statistics were:

| | |
|-----------------------|-----------------------|
| Length | 90 m |
| Beam | 15 m |
| Draft | 6 m |
| Displacement | 4870 tons |
| Cruising speed | 13 knots |
| Maximum speed | 17 knots |
| Cruising range | 23,000 nautical miles |
| Endurance | 80 days |
| Officers and crew | 64 |
| Scientific complement | 25 |

Hudson was powered by a diesel electric system composed of four diesel-driven generators and two DC propulsion motors which drove the two fixed blade propellers and a bow thruster. She was able to travel at very low speeds or remain in one position while

on station for hours. The bridge was equipped with all the navigational aids available at the time.

She was equipped with an extensive deck area fitted with numerous winches, A-frames and cranes as well as an abundance of laboratories. Four hydrographic survey launches could also be carried, as well as containers for extra space. She was also fitted with a helicopter deck and hanger as well as an oceanographic well which could be used for lowering various sensors beneath the ship without dry-docking.

Her excellent accommodations were in keeping with standards for life at sea on extended cruises and included comfortable sleeping, recreational and dining quarters for the scientific staff, officers and crew. The labs and living spaces were fully air-conditioned and there was a well-equipped sick bay. To provide stability in rough weather, *Hudson* was equipped with an anti-roll system.

Hudson was able to comfortably accommodate a large scientific contingent and conduct diverse scientific programs simultaneously in the open ocean under most weather conditions. Her ample labs, extensive working area on deck and state-of-the art equipment allowed a wide variety of operations to be carried out including testing new equipment, deploying and recovering various moorings, conducting bottle casts and plankton tows, collecting samples of seabed sediments and towing various kinds of sensors and towed arrays. Her significant endurance would allow her to travel far and stay at sea for extended periods of time.

1963

Built by Saint John Shipbuilding and Drydock Ltd. in Saint John, NB at the cost of \$7,500,000, *Hudson* was launched on 28 March and christened CSS *Hudson* in honour of Henry Hudson, the English explorer who made numerous voyages to the New World during the early 17th century seeking a northwest passage to Asia. When launched, she was considered to be the most modern oceanographic vessel in the world.

Once fitting out was completed, *Hudson* sailed from Saint John, NB to Dartmouth, NS under the command of Capt. Jack Vieau. Festooned with flags, she arrived at BIO on 23 December, 1963 where a small group of staff were on the jetty to catch the lines. She was a wonderful Christmas present for the fledgling institute. BIO was just over one year old at the time, with only about fifty professional scientific and technical staff, but growing rapidly. *Hudson* joined the fleet of four other government vessels already based at BIO: CSS *Acadia*, CSS *Kapuskasing*, CSS *Baffin* and CSS *Maxwell*. Also available to BIO for oceanographic research was the CNAV *Sackville* which was based in Halifax and operated by the Navy. The arrival of *Hudson* marked a huge increase in the ability of BIO, other government laboratories and Canadian universities to conduct oceanographic research anywhere in the world's oceans.



CSS Hudson's arrival at BIO in 1963 (Credit BIO Photo Unit)

1964

Upon arrival at BIO, the operation of *Hudson* became the responsibility of director Bill English of the Marine Sciences Branch (MSB) of the Department of Mines and Technical Surveys (DMTS) which was the lead agency at BIO at the time. Captain A. Holler was the acting marine superintendent and looked after all aspects of operating the entire BIO fleet of research vessels including programming, maintenance, crewing and provisioning.

Hudson arrived with a builder's model constructed by Philippe Demeules of Sorel, QC which was presented to DMTS upon delivery. For many years it was on display just inside the main entrance of BIO and now, repainted Coast Guard colours, it is part of the new Hudson 70 exhibit just outside the cafeteria.

At the beginning of her career, there was just one full time crew on *Hudson* who were on duty for the entire year except for holidays. The field season usually ran from April to December but winter cruises were carried out some years. The crew worked on a traditional three-watch system, each watch standing four hours on duty followed by eight hours off. This was a most demanding schedule for the crew since *Hudson* was often at sea on the order of 200 days each year.

At the start of her career, the atmosphere on board *Hudson* was quite formal with a distinct separation between officers and scientific staff and the crew. This was a carryover from *Baffin* and the other Canadian Hydrographic Service (CHS) ships. Socializing between staff and crew was discouraged and the crew were not allowed in the officers and staff lounge. The crew ate in the crew's mess while officers and staff ate in the dining room. Male staff were required to wear jackets and ties when eating while

women were required to wear skirts or dresses. Over the years, the atmosphere on board gradually became more informal as it had always been on US oceanographic ships.

Initially, *Hudson* carried bonded stores of alcohol and tobacco which were available for purchase once at sea. Officers and staff were allowed to purchase a fifth of spirits and carton of cigarettes once a week. Shots of spirits and beer could also be purchased in the lounge. Unfortunately, the abundance of cheap alcohol led to numerous drinking problems with both officers and crew so in later years the availability of alcohol was much reduced.

For much of her first year, *Hudson* was involved in conducting sea trials and fine tuning equipment to iron out the many bugs that always come with a new vessel. Most of the problems encountered involved the propulsion system. Some modifications were also carried out including installing a Swan winch with ½ inch cable on the foredeck for geological sampling. However, there also was the opportunity to initiate some scientific operations.

Hudson departed BIO for the first time on 20 January for sea trials and returned ten days later with commutator trouble on the port propulsion motor.

On 14 February, *Hudson* was formally commissioned by The Honourable W. M. Benidickson, Minister of the Department of Mines and Technical Surveys (DMTS), at a dockside ceremony at BIO. Scientists attending the ceremony included Bill Cameron, Neil Campbell, Art Collin, Bernie Pelletier, Warren Forrester, Reg Gilbert, Earl Doe, Ron Trites, John Brooke, Clive Mason, Ced Mann, George Needler, Lew King, Bosko Loncarevic and Iver Pagden. Soon after, she departed for a week of full speed and ice-breaking trials.

Cruises

Captain: Jack Vieau

Number of Cruises: 6

Days at Sea: 76

Nautical Miles Steamed (Estimated): 12,084

The first scientific assignment for *Hudson* was a hydrographic survey of the Tail of the Banks off Newfoundland in April and May (L. Murdock, BIO) (Cruises 0464 and 0764). This general charting survey extended previous Canadian Hydrographic Service (CHS) surveys in this area conducted by *Kapuskasing* in 1957 and *Baffin* in 1963. The two-range Decca Lambda system was used for navigation. On the way to Newfoundland a stop was made at Sable Island to offload equipment. Before the survey began, two slave stations were established along the Newfoundland coast using a helicopter. Heavy weather was encountered but the hydrographers found *Hudson* to be extremely seaworthy and comfortable. Unfortunately, as expected with a new ship, quite a number of malfunctions developed in her equipment. As a result of these and adverse weather conditions it was not possible to complete all the intended survey lines. Nevertheless, the time at sea served as an excellent evaluation period during which many of her shortcomings came to light.

When she returned to BIO, the port propulsion motor was not operating. This was repaired by the builder alongside at BIO and further testing indicated that both port and starboard propulsion motors were working properly. This was followed by further engine trials at sea and this time *Hudson* returned with leaking tubes in the main engine coolers which were subsequently repaired.

In June, *Hudson* sailed to Charlottetown, PEI with CSS *Acadia* to represent BIO at the annual meeting of the Royal Society of Canada and celebrations commemorating the 100th Anniversary of the Charlottetown Conference (Bernie Pelletier, BIO) (Cruise 1364). Four scientific papers were presented to the Royal Society and the decorated vessel was open to visitors for three days. While in transit to and from Charlottetown, the first geophysical investigations on *Hudson* were carried out. These included sub-bottom profiling and gravity measurements. The results indicated the presence of a large negative gravity anomaly off Cape Breton Island.

In July, *Hudson* returned to Saint John Shipbuilding and Drydock in Saint John, NB for warranty docking/refit and repairs and did not return to BIO until October. This was followed by another sea trial operation in late October during which she carried out some water column sampling along the Halifax Section across the Scotian Shelf from Halifax to the shelf break.

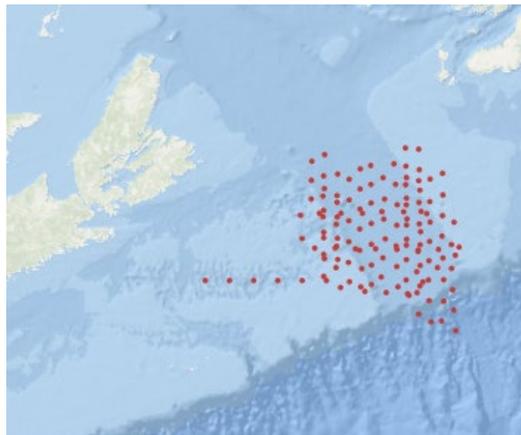
The next was a geophysical cruise in early November to the outer Laurentian Channel for further investigation of the negative gravity anomaly observed off Cape Breton in June (Bosko Loncarevic, BIO) (Cruise 2764). Approximately 2,800 km of gravimeter and magnetometer readings were collected and confirmed the existence of the anomaly which subsequently was named the Orpheus Gravity Anomaly. It was concluded that this anomaly was caused by a granitic intrusion of likely Devonian age.

This was followed by a late November cruise to the Gulf of St. Lawrence to collect temperature and salinity data in the upper 250 m of the water column for the Ice Forecast Central Office of the Department of Transport (Tom Foote, BIO) (Cruise 2964). This was the first time that *Hudson* was used primarily for physical oceanography and this ice forecasting cruise subsequently became an annual event. Profiles of pH and alkalinity were also collected, as well as a few bottom sediment samples. In addition, oceanographic and bathythermograph stations were occupied along the Halifax Section. *Hudson's* station keeping ability was judged to be first rate. However, it was noted that under rough conditions while holding station with her stern to the wind there could be considerable shuddering in the after part of the ship during high astern revolutions of the propellers. These vibrations were not considered detrimental to the ship but did make working in the after labs uncomfortable at times. It was also observed that the platform and chains arrangement in the upper deck winch room were of poor design and it was recommended that they be replaced with an arrangement as found on *Baffin*.

In December, *Hudson* carried out her first cruise for the Dalhousie Institute of Oceanography (IODal) and visited the Scotian Shelf and Sohm Abyssal Plain south of

Newfoundland (Carl Boyd, DAL) (Cruise 3064). A series of sediment cores was collected along a line from Sable Island out to the Sohm Abyssal Plain. This was her first time conducting biological studies. Sampling included dissolved and particulate organic matter, bacteria, zooplankton and benthic organisms. A heavy storm was encountered and all were most impressed with the stability of the vessel under extreme conditions, especially those who had worked earlier on smaller US oceanographic ships.

While there were still some defects to be remedied, at the end of the year the vessel was now considered to be fully operational. About this time, the cooks on *Hudson* started the tradition of making a pot of seafood chowder for the annual BIO Christmas party in the cafeteria, a much enjoyed tradition which continued for many years.



Available cruise stations for 1964

1965

The BIO shore-based ship's organization was strengthened by three appointments. Captain S.W. Howell became the new Regional Marine Superintendent. He had previously been the Director of Canadian Naval Auxiliary Vessels in Ottawa. J. M. Higgins assumed the duties of Regional Engineer Superintendent. He had served as Chief Engineer on *Baffin* from 1956 to 1961. While with GTR Campbell and Company of Montreal during 1963-64, he was on loan to the Department of Mines and Technical Surveys (DMTS) as Supervisor of Ship Construction and Maintenance and assisted in the supervision of the construction of *Hudson*. G. Smith, a qualified naval architect, formerly on the design and supervision staff of GTR Campbell and Company of Montreal, took up the position of Regional Hull Superintendent. He had broad experience in marine survey work and from 1961 to 1964 was in charge of supervision duties on behalf of DMTS during the construction of *Hudson*. In addition, Bill Ford, a physical/chemical oceanographer, arrived from the Defence Research Board in Ottawa to become the new Director of the Marine Sciences Branch (MSB) at BIO.

After the experience gained during the first full year of operations, a number of alterations were made to improve *Hudson's* operational and scientific capability. These included:

- Increasing the number of scientific accommodations from 25 to 28 by converting some single cabins into doubles
- Installing and outfitting a much needed recreation room for crew
- Installing an additional evaporator to meet an increased need for freshwater
- Extending the foredeck gallows for deep water coring
- Repositioning of ventilators and other obstructions on the foredeck to clear the working area
- Altering the foredeck section of the bulwarks on the starboard side to facilitate over-the-side operations
- Installing a cooling system for portable oceanographic winches
- Improving access to the general purpose laboratory from the adjoining boat deck by removing the small photographic lab
- Installing shelving units in the hanger, general purpose and the oceanographic laboratories
- Installing a 20 HP oceanographic winch in the boat deck laboratory, extending the boom capacity and making improvements to the oceanographic platform
- Installing additional floodlights in boat deck working areas
- Installing a 15-ton Grove crane on the flight deck to facilitate the laying of moorings and equipment (temporary)
- Installing a resilient mounting for the foredeck oceanographic winch power unit to minimize noise
- Making alterations to the oceanographic well to improve the sounding performance of transducers below the keel in bad weather

For most of her career, *Hudson* was heavily used for seismic work. In the earlier years this involved the use of explosives for running both reflection and refraction lines which was a potentially dangerous operation. Sometimes a separate DND or charter vessel was used to set off the charges while *Hudson* served only as the listening ship but at other times she served both functions. Departmental regulations required that when *Hudson* used explosives a licensed seismic shooter was necessary and with time several BIO staff received the proper training and were able to carry out this function. Using explosives on board required the construction of a 6 m steel storage container with a water-tight door which could be filled with water if needed for fire protection. This bright red container could hold up to 20 tons of explosives and was usually carried in the hanger on the helicopter deck or on the port side of the boat deck. Various types and sizes of charges (up to hundreds of kg) were deployed from the stern of *Hudson* while underway at intervals of 15-60 min. When a shot was required, the safety fuse was lit and the charge tipped over the side where it sank and exploded shortly thereafter with the time interval depending on the size of the charge and length of the safety fuse which were determined by the anticipated crustal geology. Shot lines could last for several days making this work exhausting for the few people qualified to do it. Fortunately, over the years that explosives were used on *Hudson* there were no serious accidents. Explosives were generally picked up at the DND Magazine in Bedford Basin just before leaving the

harbour. The use of explosives on *Hudson* ended in 1984 when various towed sparkers and airguns became available as reliable sound sources for seismic work.

Cruises

Captain: Jack Vieau

Number of Cruises: 7

Days at Sea: 222

Nautical Miles Steamed (Reported): 46,960

In early January, *Hudson* made her first trip to Bermuda (Tom Foote, BIO) (Cruise 165). The prime purpose was to complete deep-sea trials of oceanographic winches and associated over-the-side handling gear. In addition, numerous bathythermograph stations were conducted, continuous bathymetric soundings were made, a sediment core from the Muir Seamount was collected and some new instruments were tested. Decca and Loran were used for navigation. A brief stop was made in St. Georges to pick up some equipment flown in from Cornwall, ON.

Three days at the end of January were devoted to ice trials.

In February, *Hudson* headed south again on her first cruise devoted to fisheries work which was organized by the St. Andrews Biological Station of the Fisheries Research Board (Noel Tibbo, SABS) (Cruise 365). There were also participants from the Royal Ontario Museum, the University of Ottawa and the Woods Hole Oceanographic Institution (WHOI). From BIO, she headed for Cape Hatteras and from there to the eastern Caribbean Sea. After a port call in San Juan, Puerto Rico, where an open house was held, she headed north of the Bahamas to the Florida coast and then proceeded northward along the continental shelf up to Cape Hatteras before heading for home. The focus of the program was collecting information on the distribution, movement, size, food and spawning areas of large pelagic fish such as swordfish, tuna and sharks. Fishing was carried out using Japanese floating long lines. Oceanographic data were also collected. In addition, samples of phytoplankton and eggs and larvae of the American eel were collected. Upon return, a number of recommendations were made for improving the ability of *Hudson* for conducting biological sampling.

In early March, *Hudson* departed on her first cruise across the North Atlantic for geophysical observations (Bosko Loncarevic, BIO) (Cruise 665). Three separate investigations were carried out: long survey tracks across the Atlantic, a reconnaissance survey of the western approaches to the English Channel and a detailed survey of a section of the median valley of the Mid-Atlantic Ridge. Gravity, magnetic and bathymetric data were collected and compiled using the Geophysics Data Logger (GEODAL), a semi-automatic geophysical data logging system in the pre-microprocessor era which enabled researchers to reliably record vast amounts of data for many applications. Data were also collected on marine radioactivity and microbiology. The work over the Mid-Atlantic Ridge, a site of seafloor spreading, was particularly noteworthy for the surveys, using radar transponder buoys to position the ship, made it

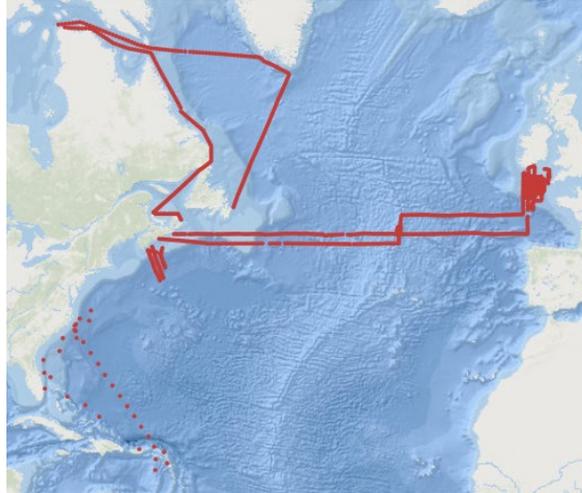
possible to compile detailed maps of bathymetry plus magnetic and gravity anomalies. During this cruise she made a port call in Bristol, UK where she showed the Canadian flag at a major British marine geology symposium and was visited by the Lord Mayor of Bristol. This was the most extensive cruise undertaken to date for *Hudson*.

In June, *Hudson* was used again by the Dalhousie Institute of Oceanography (IODal) to conduct numerous geophysical and biological projects on the continental shelf and in the Sargasso Sea (Carl Boyd, DAL) (Cruise 1565). This was the first time that women scientists sailed on board *Hudson* (Charlotte Keen, Joleen Aldous, Kai-Mai Pold, Janet Eaton and Janice Coggeshall). The program included seismic surveys using *Sackville* as the shooting ship, hydrographic casts, plankton tows, mid-water trawls, dredges and grabs. During this cruise, *Hudson* was engaged in her first search and rescue work in which she picked up a sick seaman from the cargo vessel *Export Champion* who was later transferred to a Coast Guard helicopter near Sable Island. Before resuming scientific work, *Hudson* anchored on the north side of Sable Island and transferred food supplies ashore by launch for the BIO staff stationed there.

In July, *Hudson* made her first trip to Hudson Bay (Bernie Pelletier, BIO) (Cruise 2465). The main purpose of this lengthy cruise, which was divided into three legs, was to study the geology of the Bay with a focus on sediments but extensive bathymetric surveys, seismic refraction surveys and hydrographic sampling were also carried out. The charter vessel *Theron* was used as the shooting ship for the seismic work. Launches and a helicopter were used as well as a fixed-winged aircraft. Scientific operations covered the entire Bay and major sampling equipment included an echo sounder, Nansen bottles, a seismic sub-bottom profiler, grabs, dredges and corers. During this multidisciplinary cruise, the 37-ft launch *Needlik* was lost in Hudson Bay in 181 m of water due to the parting of the after-falls while being retrieved. Fortunately, no injuries were incurred.

In October, *Hudson* returned to the Gulf of St. Lawrence to carry out further geophysical surveys in collaboration with *Sackville* and *Theron* which served as the shooting ships (G. Hobson, BIO) (Cruise 3065). The program included seismic surveys to measure the thickness, nature and attitude of sedimentary rocks underlying the Gulf. Gravity and magnetic surveys were also conducted.

The final cruise of the year was for geophysical work on the continental margin off Nova Scotia (Bosko Loncarevic, BIO) (Cruise 3465). The purpose was to test the hydrostatic rock core drill under development, gain experience in obtaining seabed photographs, establish routines for deploying bathythermographs (BTs) while underway and collect gravity and magnetic data. Charlie Hollister from the Lamont Geological Observatory of Columbia University and Director Bill Ford were on board. In honour of Charlie Hollister, a typical US Thanksgiving Day dinner was served complete with wine.



Available cruise stations/tracks for 1965

1966

The Department of Mines and Technical Surveys (DMTS) became the Department of Energy Mines and Resources (DEMNR).

The first hydrocarbon exploration well was drilled on the Grand Banks.

After last year's cable failure in Hudson Bay, which resulted in the loss of a hydrographic survey launch, the two sets of davits on the after boat deck were removed. This provided space to install two 20 ft. lab containers when required.

The newly developed BIODAL data logging system was installed on *Hudson* which included a PDP 8 computer. It was designed to be a standard data recording facility for all BIO ships. Data recorded included day number, time, ship's heading, ship's log and selected scientific measurements. It also generated a common time which was transmitted throughout the ship to all scientific stations for display and data logging.

Walter Kettle became permanent captain in May.

Cruises

Captains: Jack Vieau, Moran Wagner, Walter Kettle

Number of Cruises: 5

Days at Sea: 162

Nautical Miles Steamed (Reported): 27,914

The first cruise of the year was a two-month venture departing in March to the Labrador and Irminger seas around Greenland (John Lazier, BIO) (Cruise 266). This cruise marked the beginning of the long-term Labrador Sea program. The primary purpose was to occupy a large number of oceanographic stations to measure temperature, salinity and

dissolved oxygen throughout the water column in order to gain knowledge of the characteristics, formation and movement of Labrador Sea water, North Atlantic deep water and bottom water. This was before the days of CTDs so all data were obtained by hydrocasts using Knudsen bottles equipped with reversing thermometers. Heavy weather was experienced during most of the cruise and the excellent station keeping ability of *Hudson* ensured that the program was completed as planned. In addition, investigations of microorganisms, dissolved and particulate organic matter and sea birds were conducted by students and a postdoctoral fellow from Dalhousie. The cruise was undertaken at the end of the cooling season so that the deep convective overturn of surface water masses might be studied. Partway through the cruise, *Hudson* visited St. John's where Jack Vieau left the ship for medical reasons and Moran Wagner took over as temporary captain.

The next cruise was to the Kelvin Seamount for geophysical studies (Bosko Loncarevic, BIO) (Cruise 1066). The new hydrostatic rock core drill was successfully tested and drilled into the heavy manganese cover on top of the seamount.

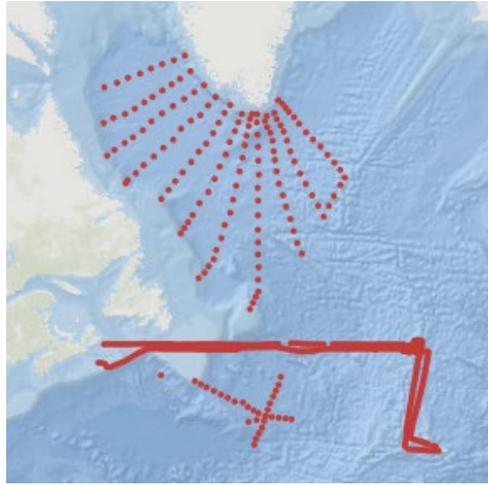
Next was another geophysical cruise, this one organized by the Dalhousie Institute of Oceanography (IODal) to investigate the structure of the crust and upper mantle beneath the continental margin off northeast Newfoundland (Mike Keen, DAL) (Cruise ???). A total of 7,000 km of sounding and magnetometer lines were completed and in collaboration with *Theta*, which served as the shooting ship, approximately 300 km of continuous seismic profiling were completed. Tests were also performed with a bottom geophone and recording buoy. Numerous bathythermograph stations were also occupied. Navigation was wholly by Loran.

In late July, *Hudson* departed for her second visit to the Mid-Atlantic Ridge to learn more about this longest mountain range in the world (Bosko Loncarevic, BIO) (Cruise 1966). This two-month geophysical cruise conducted bathymetric, magnetic and gravity surveys over the rift valley. A technique was developed for producing on-the-spot maps which were used to determine the most interesting places to sample the bottom by coring, photography and dredging. The new BIODAL data-logging system performed consistently well. Partway through, a port call was made to Ponta Delgada in the Azores. Further tests were performed with the hydrostatic rock core drill. A 4-ft long Braincon V-fin towed transducer was used successfully at speeds up to 12 knots under all sea conditions encountered. On the way back home, *Hudson* stopped for a few hours to take the first seabed photos in the Gully.

In the early fall, a marine geology cruise was made to the Gully, the large submarine canyon on the continental slope east of Sable Island (J. Marlowe, BIO) (Cruise 2666). The purpose was to obtain samples of bedrock in locations where outcropping ledges were known to occur as an aid in describing the geology of the upper continental slope. Nine bedrock samples were collected using dredge trawls, some as deep as 2,200 m.

Owing to low electrical insulation in *Hudson*'s propulsion system, it was decided to reduce her program for October and November and bring her home earlier than planned

for refit and repair. Then, on 7 October, while alongside at BIO, an engine room fire caused extensive damage to cables which made it necessary to cancel the remaining program for the year.



Available cruise stations/tracks for 1966

1967

The first hydrocarbon exploration well was drilled on the Scotian Shelf.

Cruises

Captain: Walter Kettle

Number of Cruises: 8

Days at Sea: 189

Nautical Miles Steamed (Reported): 28,907

The year began with a major cruise from January to April to the northeast Atlantic (Ced Mann, BIO) (Cruise 267). The many objectives were to measure the volume of the Norwegian Sea overflow through Denmark Strait into the North Atlantic, study the sinking of water off east Greenland in winter and the spreading of Labrador Sea Water, measure the volume of Norwegian Sea overflow from the Iceland-Scotland area as it flows along the Reykjanes Ridge, conduct a magnetic survey of a ridge north of Iceland and measure the velocity of the deeper water in the North Atlantic Current as it passes Flemish Cap. Temperature, salinity, oxygen and dissolved silica were measured throughout the entire water column at a network of 119 hydrographic stations. In addition, vertical profiles of temperature were obtained at 40 selected stations using a bathysonde for the first time. Current meter moorings were also deployed. This cruise was an international undertaking in cooperation with scientists from the National Institute of Oceanography (NIO), UK, headed by John Swallow, and the Woods Hole Oceanographic Institution (WHOI), USA, headed by Val Worthington. Partway through a port call was made at Hafnarfjordur, Iceland to repair storm damage and exchange

personnel. Later port calls were made in Belfast and Londonderry, UK plus a return visit to Hafnarfjordur. The ship's endurance was rigorously tested with icing of the ship's superstructure, extreme wind and wave conditions and low air temperature but due to *Hudson's* unique design features and sea-keeping ability the program was completed successfully.

In late April, *Hudson* sailed to Montreal, QC to be on public display for a week at Expo 67, the World's Fair celebrating Canada's centennial (Reg Gilbert, BIO) (Cruise 1067). She departed BIO in a carnival spirit with the Minister of DEMR, the Director of BIO and the Premier of Nova Scotia on the jetty waving goodbye. Over 20,000 visitors toured the ship and viewed the various exhibits on display, including the hydrostatic rock core drill under development. Numerous BIO staff and Dalhousie students served as guides. Apparently there were so many visitors that the signs pointing out its presence had to be removed. The ship also carried seawater in the ballast tanks for the Expo 67 aquarium. Meanwhile, while *Hudson* was receiving many visitors at Expo 67, the *Baffin* was in Monaco waving the Canadian flag at an international hydrographic conference and hosting cocktail parties with lobster sandwiches on the helicopter deck.



CSS Hudson alongside at Expo 67 (Credit BIO Photo Unit)

Upon return to BIO, her next cruise was to carry out physical oceanographic and geological studies on the Scotian Shelf and in the Gully (Ron Trites, BIO) (Cruise 1267). Specific objectives included using moored buoys to measure current speed and direction, measuring temperature and salinity along the Halifax Section, studying the distribution of living planktonic foraminifera and collecting samples of bedrock. Dredging operations north of Sable Island yielded several hundred pounds of bedrock later identified as lower Cretaceous in age. Bottom grabs and vertical planktonic hauls were made at 10 stations.

Next was a lengthy engineering and biological cruise to the San Pablo Seamount in the Sargasso Sea, the Grand Banks and Flemish Cap carried out in collaboration with the Dalhousie Institute of Oceanography (IODal) (Reg Gilbert, BIO) (Cruise 1967). The first leg was from BIO to the San Pablo Seamount and then to St. John's. The second leg was from St. John's to the Flemish Cap and then to BIO. The third leg was from BIO out again to the San Pablo Seamount and return. The main activity was testing and modifying new instrumentation under development including the hydrostatic rock core drill, a towed porpoising fish, a wave recorder, an underwater movie camera, a radio-controlled launch, a heat flow corer and an electronic plankton counter. Numerous bottle casts for studies of non-living organic carbon and plankton tows were also made plus samples of bedrock and surficial sediments were collected. This was the first cruise on *Hudson* with scientists of many different disciplines working together and the multidisciplinary nature of the program meant that the ship was fully utilized around the clock.

In August, *Hudson* returned to the Gulf of St. Lawrence for a cruise with two legs (Max Dunbar, McGill/ Doug Loring, BIO) (Cruise 2467). This was the first time that she was used by McGill University. The purpose was to investigate the distribution of low oxygen water in the deeper parts of the Gulf, collect temperature and salinity data for biological and geological studies, study the nature and distribution of suspended matter, collect zooplankton (in particular fish eggs and larvae) and collect sediment cores. A large number of stations were occupied including the Strait of Belle Isle and Cabot Strait.

In September, a geological cruise was carried out on the Scotian Shelf (Lew King, BIO) (Cruise 2767). Nine piston cores were obtained in clay and silt units and subsequently used for stratigraphic, paleontological, and radiogenic studies. Forty-seven bedrock samples were collected by dredge and 200 km of airgun seismic profiling were obtained.

The final cruise of the year for *Hudson* was to Bermuda in October for physical oceanographic studies (J. Butters, Maritime Command) (Cruise 3167).



Available cruise stations/tracks for 1967

1968

At BIO, the Marine Sciences Branch (MSB) was renamed the Atlantic Oceanographic Laboratory (AOL) and the Atlantic Oceanographic Group (AOG) was renamed the Marine Ecology Laboratory (MEL). In October, The Right Honourable Roland Michener, the Governor-General of Canada, visited BIO and was given a tour of *Hudson*. Also this year, the brand-new *Dawson* joined the BIO fleet of research vessels, while on the west coast her sister ship *Parizeau* joined the fleet at the Institute of Ocean Sciences (IOS) in Sidney, BC.

A state-of-the art Raytheon Transit Satellite navigation system was installed. This resulted in *Hudson* becoming the first non-USA and non-military ship in the world to be navigated by satellite.

Cruises

Captain: Walter Kettle

Number of Cruises: 6

Days at Sea: 249

Nautical Miles Steamed (Reported): 39,179

The year began with a major multidisciplinary two-month winter cruise to the Caribbean (J. Marlowe, BIO) (Cruise 668). Because of the time of year and destination, this cruise was very popular and a large number of non-BIO partners participated including McGill University, Lamont Geological Observatory, University of South Carolina, Woods Hole Oceanographic Institution (WHOI), Queens University, National Museum of Canada, Cambridge University, University of Pennsylvania and University of Ottawa. Work was carried out in the Anegada Passage, Grenada Trough, waters adjacent to the Grenadine Islands, St. Lucia, St. Vincent and Grenada, Gulf of Cariaco and Cariaco Trench. Port calls were made at Castries on St. Lucia, Cariaco on Grenada, Port Elizabeth on St. Vincent and Port-of-Spain on Trinidad. Bathymetric, gravity and magnetic surveys were conducted enroute in both directions. Measurements were made of the flow of Atlantic water into the Venezuelan Basin through the Anegada Passage. Numerous bottle casts, plankton tows and coring and dredging operations were carried out. In addition, numerous hydrographic, geological and biological surveys were conducted on behalf of the Federation of Caribbean States. It was found that *Hudson's* air conditioning system was not adequate for the heat encountered and it was recommended that this be corrected before further cruises were made to the tropics.

Next was a lengthy geophysical and engineering cruise (Bosko Loncarevic, BIO) (Cruise 2268). The original intention was to spend all the assigned time working on the Mid-Atlantic Ridge. However, a federal election was called for 25 June and *Hudson* was required by Ottawa to be at BIO on that day so that crew members could vote. As a result, the cruise had to be divided into two legs.

The first leg visited the San Pablo Seamount and Bermuda Banks. Partway through a port call was made in Bermuda to exchange personnel. For most of the cruise, bathymetric, magnetic and gravity data were recorded continuously. A short seismic survey was conducted on the Bermuda Banks using a lifeboat as the shooting vessel. Further tests on the hydrostatic rock core drill under development were carried out. In addition, various kinds of new equipment were tested including rock dredges, data logging systems, sounding transducers, pingers, sonobuoys, cameras and the porpoising tow fish. Problems with the ship's air conditioning system continued.

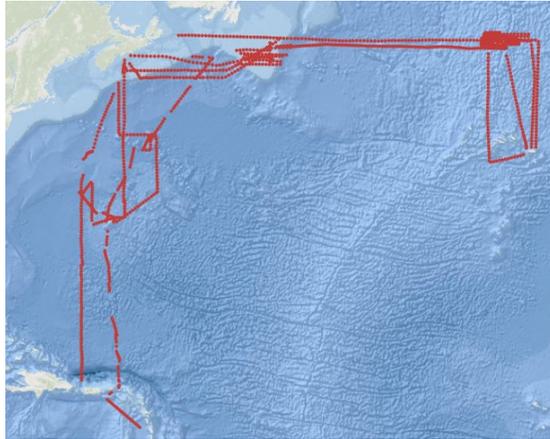
The second leg was out to the Mid-Atlantic Ridge. This was the third visit by *Hudson* to the Ridge and, with the assistance of *Theta*, continued the comprehensive geophysical investigation of the median rift valley area between 45° N and 46° N. Two seismic experiments were carried out in conjunction with Dalhousie and Cambridge universities. *Theta* dropped the charges while *Hudson* served as the receiving station in the centre of a square pattern of sonobuoys. Rock samples, eight deep-sea cores and 69 plankton tows were collected. Numerous camera stations were also made. In addition, the physical and chemical properties of deep water in the median valley were measured. While working on the Ridge, two trips were made into Ponta Delgada in the Azores to exchange personnel. Bathymetric, magnetic and gravity data were recorded continuously while in transit across the North Atlantic to and from the survey area.

In October, a return visit was made to the San Pablo Seamount for further testing of the hydrostatic rock core drill (John Brooke, BIO) (Cruise 3968). This seamount was the closest suitable site to BIO for testing but its proximity to the strong Gulf Stream currents made it a difficult place to work. The nearby Rehoboth Seamount, another of the New England seamounts, was also visited for further tests. Both seamounts were drilled successfully.

Soon after, a 12-hour cruise was conducted off Halifax to demonstrate the operation of *Hudson* as an earth science research ship to delegates attending the Symposium on Marine Sub-bottom Exploration methods held at BIO (Dave Ross, BIO) (Cruise 5868). A total of 144 km of gravity, magnetic and bathymetric data were collected. Coring equipment was demonstrated and underway trials of the Hunttec boomer under development were conducted.

In late October and early November, *Hudson* made a cruise to the Sargasso Sea south of Bermuda to carry out various biological and chemical studies for the Dalhousie Institute of Oceanography (IODal) (Bob Fournier, DAL) (Cruise 6168).

The final cruise of the year was a return visit to the Rehoboth Seamount for further testing of equipment under development at BIO (Clive Mason, BIO) (Cruise 6068). These included the hydrostatic rock core drill, a temperature profiler, acoustic command systems, commercial pingers, transponder buoys and the undulating towed body now named Batfish. In addition, seawater samples were collected for the study of an ion-exchange technique for separating trace metals in seawater.



Available cruise stations/tracks for 1968

1969

The Honourable J. J. Greene, Minister of the Department of Energy, Mines, and Resources, announced in the House of Commons the forthcoming Hudson 70 Expedition, a year-long cruise of *Hudson* around North and South America. A PDP8 computer was permanently installed.

Shell Canada made Canada's first offshore natural gas discovery at the Onondaga well south of Sable Island. The tanker *Manhattan* made her historic voyage through the Northwest Passage from west to east.

On 6 April, Captain Walter Kettle died suddenly from heart failure. An outstanding captain, he was a Newfoundlander who had served with distinction in the Royal Canadian Navy (RCN) during World War II and then the Canadian Merchant Marine at the end of hostilities. He later served as captain of *Acadia* and *Baffin* before joining *Hudson* in 1966. Captain Kettle pursued a career which commanded respect and admiration. He made very great contributions to the work of the Canadian Hydrographic Service (CHS) and oceanographic research. Not only did he command his ship with great ability and act as a firm but kindly father to all aboard but he could also handle a ship superbly and was always on hand when any particularly difficult operation was taking place. He was always extremely interested in the survey or scientific work being carried out from his ship and his enthusiasm infected the rest of the ship's company which created an atmosphere noted with envy by many visiting scientists who took part in cruises with him. While he was missed, the traditions he established in the BIO fleet endured for many years and he was remembered as an outstanding captain. He was replaced by David Butler.

Major alterations were made in the data logging centre of *Hudson*. A new console area enclosed in an air-conditioned space necessitated the removal and re-installation of the

data logging equipment, satellite navigation receiver and computer. The radar systems were also updated.

The prototype, variable-depth echo-sounder transducer was redesigned and installed in the ship's well. This new assembly ensured rigidity, stability and ease of installation. The transducer dome could now be lowered to a depth of four feet below the hull in less than a minute. Four BIODAL sounding systems were now on the *Hudson* in the newly constructed console, the plotting area for ship navigation on the bridge, the oceanographic lab and the winch lab. All units were driven by master clock/timing generator.

Cruises

Captain: David Butler

Number of Cruises: 8

Days at Sea: 185

Nautical Miles Steamed (Reported): 27,943

The field season began with a short cruise in April just off Halifax for further equipment testing (John Brooke, BIO) (Cruise 69-020). This was planned as a shakedown cruise for equipment to be used on a major cruise later in the summer. Tests were conducted for a multiple plankton sampler, an acoustic command system, a new capstan winch for the rock core drill and radar transponders.

The next cruise was to the Sargasso Sea around Bermuda and organized by the Dalhousie Institute of Oceanography (IODal) (Pete Wangersky, DAL) (Cruise 69-024). A wide variety of biological and chemical studies were carried out by faculty and students.

This was followed by a major two-month cruise across the North Atlantic to Portugal which involved many BIO components (Bernie Pelletier, BIO) (Cruise 69-025). The purpose was to carry out an integrated multidisciplinary project to further elucidate the history of the Atlantic seafloor with reference to the process of continental drift, seafloor spreading and the relationships of these phenomena to the Canadian eastern seaboard and its economic potential. Extensive bathymetric, geophysical, geological and oceanographic surveys were carried out enroute. Rock core drill samples (both hydrostatic and electric) were collected as well as seabed photographs, grabs and piston cores. Information was also collected on the distribution and ecology of modern foraminifera. While data were collected along the entire cruise track, surveys concentrated on the Flemish Cap and the Mid-Atlantic Ridge. Halfway through the cruise, a port call was made in Lisbon and, at the request of Portuguese authorities, a bottom sampling program was carried out in Lisbon Harbour and approaches as a gesture of courtesy. This ambitious cruise was most successful but unfortunately was marred by the deaths of the ship's doctor, Fritz Backman, and the chief Steward, Godfrey Boudreau. According to his wishes, Dr. Backman was buried at sea.

This was followed by a short cruise off Halifax with the National Film Board (Clive Mason, BIO) (Cruise 69-044).

In August, a cruise to the Sargasso Sea was made along the Halifax Line for physical oceanographic studies (John Butters, DND) (Cruise 69-047).

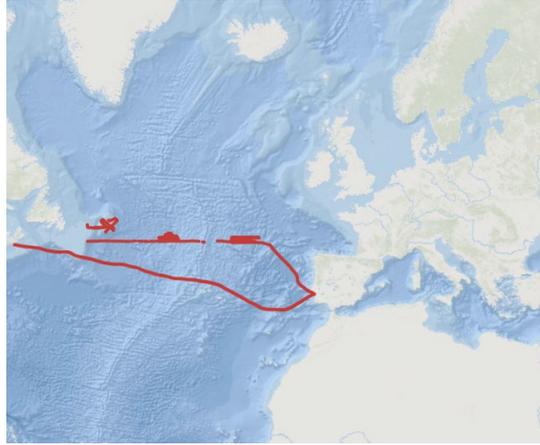
Next was a month-long geological cruise in September organized by the Dalhousie Institute of Oceanography (IODal) (Rudi Gees, DAL) (Cruise 69-040).

This was followed by a short four-day cruise in early November to the Scotian Shelf to check out equipment before departing on Hudson 70 (Ced Mann, BIO) (Cruise 69-046).

In mid-November, *Hudson* departed on Hudson 70, the most ambitious oceanographic cruise ever mounted by Canada (Cruise 69-050). Encircling both North and South America, it took 330 days and traversed 104,000 km in the Atlantic, Pacific and Arctic oceans. There were 128 participating scientists from five countries (Canada, US, UK, Argentina and Chile), most of whom were from BIO and Dalhousie University. Research programs were carried out in an extensive list of scientific disciplines including physical oceanography, chemical oceanography, biological oceanography, marine geology, geophysics, geodesy, hydrography and underwater acoustics. *Hudson* was ideally suited for such an ambitious venture. The cruise was divided into nine legs.

After a year of hectic preparation, the freshly painted and fully provisioned *Hudson* departed BIO for the first leg on 19 November after sendoff speeches, including by the Honorable Joseph Greene, the Minister of the Department of Energy, Mines and Resources (Ced Mann, BIO) (Cruise 69-050). She proceeded south conducting gravity, magnetic and bathymetric surveys and acoustic reverberation research along the way. Upon reaching the Equator at 30°W, she began a line of oceanographic stations down the 30°W meridian in the South Atlantic. Water samples throughout the water column were collected for the determination of temperature, salinity, oxygen, nutrients and particulate organic carbon. Other work included a deep scattering layer study using one-pound explosive charges, Isaacs-Kidd mid-water trawls and vertical plankton tows. Measurements of primary production were also carried out. On the passage between stations at night, a Neuston net was deployed to catch surface fish and zooplankton. Whenever whales were spotted, the ship stopped to take acoustic recordings. Upon reaching 25°S, *Hudson* turned to the northwest and proceeded to Rio de Janeiro.

Upon departing Rio in December for the second leg (Ced Mann, BIO) (Cruise 69-050), the *Hudson* resumed the line of stations southward along 30°W. The station routine was the same as Leg 1 with the exception that piston core samples of seafloor sediment were added to each station. Christmas Day was spent at 32.5°S and New Year's Eve occurred at 47.5°S with suitable celebrations.



Available cruise stations/tracks for 1969 (not including start of Hudson 70)

1970

The *Arrow* oil spill occurred in Chedabucto Bay. This was the first major oil spill in Canada. *Hudson* would have been involved in the followup activities had she not been so far from home. Bill Ford had planned to join Hudson 70 but had to stay at BIO to lead the Operation Oil cleanup operation.

Cruises

Captains: David Butler/Fred Mauger

Number of Cruises: 1 (Hudson 70)

Days at Sea: 205

Nautical Miles Steamed (Reported): 42,332

The second leg of the Hudson 70 expedition continued in the South Atlantic. At the southern limit of the southward transect, *Hudson* encountered icebergs, albatrosses, penguins, a full spectrum of other Antarctic birds as well as fin and pilot whales. Turning to the northwest, she investigated a gap in the Scotia Ridge, which was thought to be a northward route for Antarctic Bottom Water, and then sailed for Buenos Aires.

From Buenos Aires, *Hudson* sailed southward on the third leg toward Cape Horn making seabird observations on the way (Ced Mann, BIO) (Cruise 69-050). She then entered Magellan Strait, made a call at Punta Arenas, Chile, and threaded through the Beagle Channel to make another port call in Puerto Williams, Chile, the southernmost settlement in the world. Here, some biologists left the ship for a month to study coastal and beach fauna using a survey launch. After conducting some bottom sled stations and plankton tows off the Wollaston Islands, *Hudson* then proceeded further south. After passing Cape Horn in unusually calm conditions, she entered the Drake Passage and sought out areas of level seabed suitable for deploying a line of current meter moorings, one of the original justifications for the expedition. Once suitable sites were located, four moorings were deployed. Each mooring consisted of a railway wheel at the bottom, a subsurface float at

the top and Braincon current meters at 150 m, 1,500 m and 100 m above the bottom. Standard oceanographic stations were carried out at each location. Once the moorings were deployed, *Hudson* sailed further south and began a sampling program among the South Shetland Islands off the Antarctic Peninsula. This included plankton tows, rock dredge sampling, epibenthic sled tows and grab sampling. This program was interrupted when it became necessary to return to Puerto Williams to drop off a technician whose son had just died. While there, the biologists working in the launch were resupplied. *Hudson* then headed south again to recover the current meter moorings and carry out a line of closely spaced oceanographic stations across the Drake Passage. All were relieved when the moorings were recovered in good order. *Hudson* then returned to the South Shetland Islands for some further biological sampling before returning to Puerto Williams to recover the launch party and steaming to Punta Arenas.

The fourth leg was run by the Institute of Oceanography, University of British Columbia, and included a contingent of Chilean scientists (George Pickard, UBC) (Cruise 69-050). The purpose was to study the oceanography of the little known Chilean fjords. Seabird observations were also made. Heading northward, *Hudson* made her way through an intricate web of fjords and surveys were conducted in 32 of them, many for the first time. *Hudson* then sailed westward into the open Pacific Ocean to visit Juan Fernandez Island and carried out a short transect of stations before steaming to Valparaiso.

Departing Valparaiso on the fifth leg, *Hudson* sailed southwest toward 65°S 150°W (Russ Melanson, BIO) (Cruise 69-050). On the way, she passed over a previously unknown underwater peak and deep trough. These were subsequently named after *Hudson* and are now shown as such on international charts. Unfortunately, a high concentration of icebergs was encountered before reaching 65°S as planned so the ship was forced to turn north at 63°S 150°W where it began the longest south-north transect of continuous oceanographic sampling ever completed. In addition, gravity data were collected to allow the calibration of a radar satellite altimeter about to be launched. The oceanographic sampling program was similar to that conducted in the South Atlantic. At 16°30'S, sampling operations ceased and the *Hudson* headed to Papeete, Tahiti.

Upon leaving Tahiti on the sixth leg, *Hudson* returned to where sampling had ceased on the previous leg and resumed the sampling program of continuous gravity measurements and periodic oceanographic stations while heading north along 150°W toward Alaska (Bill Cameron, MSB Ottawa) (Cruise 69-050). At the oceanographic stations, data were collected on temperature, salinity and oxygen throughout the water column. A variety of plankton tows continued to be made. Planktonic foraminifera were collected at pre-programmed depths with a new sampler. In addition, detailed measurements were made on the size distribution of particles in surface water. Crossing the Equator marked the end of six months working in the Southern Hemisphere. The sampling program along 150°W was terminated over the Aleutian Trench at 57°30'N. This marked the end of an unprecedented 13,300 km north-south sampling transect. From here, the ship proceeded to Vancouver, the first Canadian port since departing Halifax eight months earlier. Upon arrival, *Hudson* was warmly welcomed and hosted an open house. The ship then moved

to Esquimalt, just outside Victoria, for engine repairs which took almost a month to complete.

The seventh leg was devoted to conducting geophysical surveys in the region west of the Queen Charlotte Islands (Haida Gwaii), the northern termination of the Juan de Fuca Ridge and the area surrounding the Explorer Trench (Charlie Maunsell, BIO) (Cruise 69-050). This area was of special interest to geophysicists studying plate dynamics for it marked the location where the American, Juan de Fuca, and Pacific crustal plates meet at a 'triple junction'. The program, conducted with the assistance of the CNAV *Endeavour*, involved bathymetric, gravity and magnetic surveys as well as reflection seismic profiling. Fred Mauger served as interim captain on this leg so Dave Butler could take some well-earned vacation.

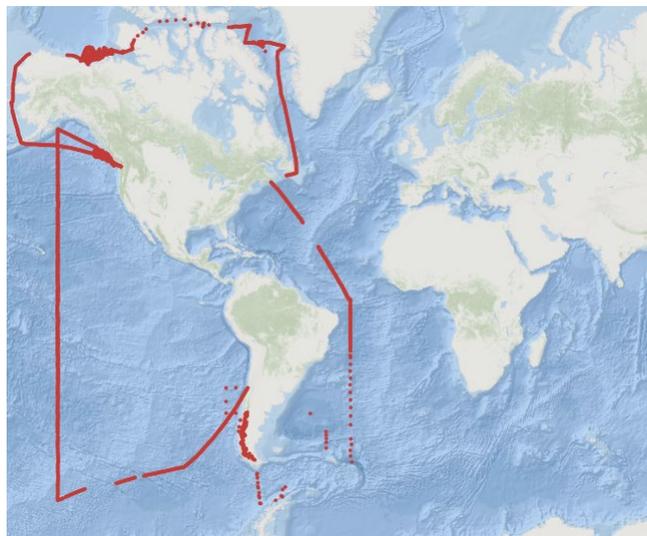
Departing Victoria on the eight leg in August, *Hudson* sailed westward toward the Aleutian Islands, now equipped with a helicopter for ice reconnaissance (Bernie Pelletier, BIO) (Cruise 69-050). She was now accompanied by *Baffin* who had sailed from BIO by way of the Panama Canal to assist with the work in the Beaufort Sea and the passage through the Northwest Passage. In addition, the recently commissioned *Parizeau* from Victoria participated in the Beaufort Sea program. At Unimak Island, *Hudson* entered the Bering Sea. Soon after, a generator exploded which decommissioned one of her four engines for the duration of the voyage. After crossing the Arctic Circle, heavy pack ice was encountered off Point Barrow which necessitated some backing and ramming. However, after crossing US-Canada boundary, the pack ice was located much further offshore and this allowed the first intensive oceanographic survey of the southern Beaufort Sea to be carried out as planned. The only previous oceanographic work in this part of the Beaufort Sea had been a few stations done from the Royal Canadian Mounted Police schooner *St. Roch* during her epic transit of the Northwest Passage in 1940. Gathering oceanographic information from this region was high priority at the time for the Canadian Government because of active hydrocarbon exploration by industry and a successful oil discovery in 1969 at Atkinson Point in the MacKenzie Delta. A survey grid of parallel lines was established running northward from the coast out to the edge of the pack ice, along which seismic profiling and bathymetric, gravity and magnetic measurements were made. In addition, a sidescan sonar fish was deployed to examine seabed features. *Hudson* stopped periodically for hydrocasts, sediment cores and seabed photography. Extensive seabed scouring by ice was observed out to depths of 100 m. Numerous underwater pingos were discovered similar to those observed on land in the Mackenzie Delta. These ice-cored mounds, looking like small conical volcanoes, rose as much as 70 m from the seabed and posed a potential hazard to shipping. Fortunately, the oil tanker SS *Manhattan* did not strike any while passing through this area the previous year on her precedent-setting passage through the Northwest Passage. This new information on geohazards was extremely valuable in managing future drilling activity. During this leg, staff produced a newsletter called the Hudson Chronically Horrid. At the end of the survey, scientific personnel were exchanged by helicopter at Tuktoyaktuk and *Hudson*, accompanied by *Baffin*, set off to navigate the Northwest Passage along the northern route through Prince of Wales Strait and Parry Channel.

Heavy pack ice was encountered partway through and the Coast Guard icebreaker *John A. MacDonal*d had to be called from Resolute, on Cornwallis Island, to break a channel. Some hydrocasts and bottom grabs were made along the way. Polar bears were frequently observed. Once completed, the successful passage through the Northwest Passage was duly celebrated. The final port of call of Hudson 70 was Resolute. While there, a bronze and aluminum plaque commemorating the voyage, made by the bo'sun Joe Avery, was installed on a rock outcrop at nearby Cape Martyr. This plaque was revisited in 2002 and, except for a few bullet holes was in good condition.

The final leg of Hudson 70 was a geophysical survey of northern Baffin Bay involving two-ship seismic refraction work (David Ross, BIO) (Cruise 69-050). The US Coast Guard icebreaker *Edisto* served as the shooting ship and *Hudson* served as the listening ship. This survey demonstrated that underlying rocks in this region are oceanic rather than continental in origin. Once this survey was completed, the BIO staff on *Edisto* were transferred to *Hudson* which then headed for home. At first, it was planned to pass inside Newfoundland through the Strait of Belle Isle but then it was recognized that *Hudson* should pass outside of Newfoundland over the Grand Banks so it could truly be said that she circumnavigated the Americas.

On 16 October, *Hudson*, accompanied by *Baffin*, returned to BIO escorted by a fire boat and other watercraft while coming up the harbour under the MacDonal

d Bridge and the recently completed McKay Bridge. It was a most fitting welcome home after an absence of almost a year. A large crowd gathered on the jetty and welcoming speeches were made by Bill Ford and the Honourable Joseph Greene. The Honourable Joseph Greene also presented Captain David Butler with a commemorative plaque celebrating the successful completion of the expedition. All Hudson 70 participants were later presented with commemorative medallions.



Available cruise stations/tracks for Hudson 70

1971

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

The first hydrocarbon exploratory well was drilled on the Labrador Shelf.

Capt. David Butler received an honorary degree from Brock University for his skill and seamanship in commanding *Hudson* during the Hudson 70 Expedition and his contributions to the science of the sea in the great tradition of adventuring.

The year began with a three-month refit at the Saint John Shipbuilders and Drydock Company in Saint John, NB. This was her first major refit since delivery.

Cruises

Captains: David Butler/David Deer/Moran Wagner

Number of Cruises: 4

Days at Sea: 163

Nautical Miles Steamed (Reported): 29,996

The first scientific operation of the year was a month-long joint geological and geophysical spring cruise to the Scotian Shelf, Gulf of Maine and Bay of Fundy (Lew King, BIO) (Cruise 71-014). A total of 12,700 km of gravity and magnetic data were collected as well as 4,860 km of continuous seismic reflection coverage. This new information allowed the completion of a 1:1,000,000 bedrock chart of the region. Samples of bedrock were collected by dredge and samples of sediment were collected by van Veen grab and piston core. In addition, echogram coverage and additional seabed sampling provided sufficient data to compile a fairly detailed map of the surficial geology of this region.

This was followed by a return visit to the Mid-Atlantic Ridge organized by the Dalhousie Department of Geology for further geophysical studies (Fab Aumento, DAL) (Cruise 71-022). Several BIO scientists also participated. This cruise, entitled "1971 Deep Drill", was divided into two legs. The purpose was to carry out further geological and geophysical investigations over a small area of the crest of the Mid-Atlantic Ridge at 45° N which had been studied on previous *Hudson* cruises. Some 261 stations were occupied. An attempt was made to collect a large number of rock samples in the median

valley using the hydrostatic rock core drill but only six could be collected due to the rough terrain. Other work included camera stations, piston coring, free-fall cameras and grabs, boomerang corers, heat flow measurements, seismics, magnetics, water sampling and plankton tows. Partway through the cruise a port call was made at Ponta Delgada in the Azores to exchange personnel.

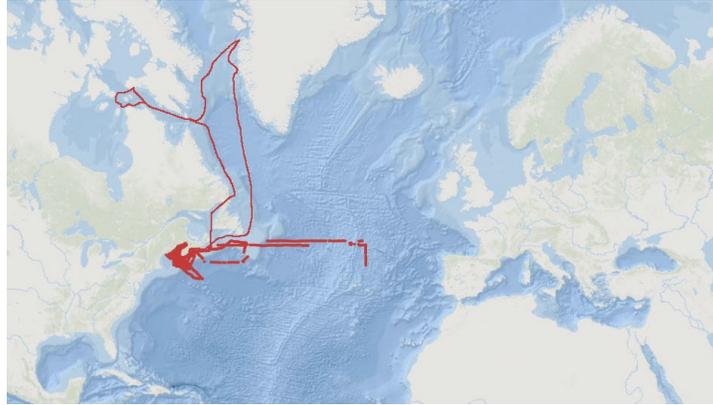
Next was a major two-month geophysical cruise to the eastern Arctic with work in Hudson Bay, Labrador Sea and Baffin Bay (David Ross, BIO) (Cruise 71-032). It was divided into four legs: BIO to Cape Dorset (Baffin Island), Cape Dorset to Thule (Greenland), Thule to Godthaab (Greenland) and Godthaab to BIO. As well as BIO personnel, observers from other government agencies and industry also participated. In addition, a cooperative program was carried out in collaboration with Danish scientists from the Greenland Geological Survey. The purpose was to conduct seismic refraction work off Southampton Island in Hudson Bay, collect seismic reflection and refraction, gravity and magnetic data of the crustal structure of Baffin Bay and adjoining continental margins in order to assess resource potential (i.e. hydrocarbons), observe pelagic seabirds as part of the PIROP program (Program intégré de recherches sur les oiseaux pélagiques), collect dredge samples from Baffin Bay, collect samples of tar balls at the sea surface while underway by Neuston net and finally collect water samples in the Labrador Sea for trace element analysis. While in Godthaab, *Hudson* was visited by the Prime Minister of Greenland.



CSS Hudson in the Canadian Arctic (Credit BIO Photo Unit)

The final cruise of the year was a ten-day trip to the northwest Atlantic for physical oceanographic and geological studies (C. Maunsell, BIO) (Cruise 71-037). The purpose was to test a variety of new sea-going computers including a PDP-11, a Super Nova and

an HP for hard drive stability in rough seas in order to find a replacement for the current onboard computers. It also had a geological component to conduct a regional seismic reflection profile across the Scotian Shelf and to collect manganese nodules from San Pablo Seamount in the New England Seamount Chain. Despite leaving the harbour in a November storm, the cruise was most successful. Manganese nodules were dredged and passed on to the Technical University of Nova Scotia for analysis.



Available cruise stations/tracks for 1971

1972

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

The Nova Scotia Technical College awarded Dr. Cedric R. Mann the degree of Doctor of Engineering *honoris causa* for his work on the Hudson 70 Exhibition. Satellite navigation was now standard on *Hudson* and employed a PDP-11 computer. A film on the Hudson 70 Expedition was released by the National Film Board of Canada.

Cruises

Captains: Moran Wagner/David Butler

Number of Cruises: 5

Days at Sea: 130

Nautical Miles Steamed (Reported): 24,249

The first cruise of the year was a four-day venture in January to Placentia Bay, Newfoundland (Des Dobson, BIO) (Cruise 72-001). The purpose was to collect current data in the approaches to Come-by-Chance, the site of a proposed oil refinery.

This was followed by a major 60-day cruise to the Tail of the Grand Banks (Bob Reiniger, BIO) (Cruise 72-008). The prime objective was to obtain a better

understanding of the Gulf Stream in the area southeast of the Grand Banks. The program was designed to study the flow pattern, the water budget, its relationship to the water budget of the Atlantic and the dynamics of the currents. A secondary objective was to study the flow of deep water from the Newfoundland Basin into the North Atlantic Basin. The *Hudson* was joined on this international venture by the *Chain* from the Woods Hole Oceanographic Institution (WHOI) and the *Cirolana* from Lowestoft, UK. Measurements included bottle casts for temperature, salinity and oxygen determination. Current meter moorings were also deployed. *Hudson* again demonstrated her superior station keeping ability in all kinds of weather. The newly developed experience in deploying current meters in the Gulf Stream played a major role in the success of this program which was completed ahead of schedule. During the cruise, *Hudson* was diverted to rescue the crew of a burning fishing vessel near the Southeast Shoal on the Grand Banks.

During July, a geophysical cruise was carried out on the continental margin off Nova Scotia and the Grand Banks (Charlotte Keen, BIO) (Cruise 72-021). The objectives included determining where oceanic crust terminates as the continental margin is approached, looking for evidence of transform faulting along the southern edge of the Grand Banks, seeking evidence of seafloor spreading from magnetic lineations and collecting geological samples wherever possible. A total of 7,408 km of bathymetric, gravity and magnetic data were collected along with 2,778 km of seismic reflection profiling. Seismic refraction data were also collected at some locations using sonobuoys. A few dredge and core samples were also collected. The addition of Loran-C to the navigational aids on *Hudson* allowed a precision which was previously impossible in this area of the Atlantic. Unfortunately, the cruise had to terminate earlier than planned when a breakdown in one of the ship's auxiliary generators forced an early return to BIO.

During October, *Hudson* undertook a cruise to carry out hydrographic and geophysical operations in the Labrador Sea and along the southern margin of the Grand Banks (Ron Macnab, BIO) (Cruise 72-025). Bathymetric, gravimetric and magnetic data were collected along east-west lines situated 18 km apart. In addition, seismic reflection measurements were obtained over certain portions of the tracks. The satellite and Loran-C navigation systems were compared.

The last cruise of the year was a five-day geophysical operation on the Scotian Shelf just off Halifax to evaluate gravity meters (Bosko Loncarevic, AGC) (Cruise 72-036).



Available cruise stations/tracks for 1972

1973

Voyage to the Edge of the World by Alan Edwards was published. This book told the story of the Hudson 70 Expedition.

The Cohasset oil and gas field was discovered on Sable Island Bank which later formed part of the Cohasset-Panuke Project (Copan).

A sewage treatment system was installed on *Hudson*. Moran Wagner took over as permanent captain and to be later replaced by David Deer.

Cruises

Captains: Moran Wagner/David Deer

Number of Cruises: 7

Days at Sea: 209

Nautical Miles Steamed (Reported): 34,314

The first cruise of the year was to the Sargasso Sea along the Halifax-Bermuda Section to collect samples for various geological, chemical and biological studies (Don Gordon, BIO) (Cruise 73-002). This was the fifth cruise in this multidisciplinary program which included participants from AOL, AGC, DOE, FRB and Dalhousie. Specific projects on the downward leg included measuring the concentrations of petroleum hydrocarbons, organochlorine pollutants and non-living organic matter in seawater, collection of floating tar balls, collection of phytoplankton and zooplankton, seabird observations and identification of hydrocarbon-oxidizing bacteria. A port call was made in St. Georges, Bermuda to exchange personnel. Due to fine weather and extra time available the crew was able to do some needed painting on the superstructure during the day and enjoy visits to the Whitehorse Tavern in the evening. On the return leg (Keith Manchester, BIO), projects included placing a sediment trap on top of a seamount, dredging the tops of seamounts for manganese crusts, plankton tows and more collecting of tar balls.

This was followed by a winter cruise to the Gulf of St. Lawrence to measure temperature and salinity in the water column (Mohammed Hassan, BIO) (Cruise 73-004). Participants from McGill were also on board. A total of 220 stations using a new

Guildline CTD (conductivity, temperature and depth) system were occupied throughout the Gulf. Extremely heavy ice conditions meant that the program had to be shortened from what was originally planned. Nevertheless, a good picture of winter conditions was obtained.

Next was a geological cruise in April to the Laurentian Channel, St. Pierre Bank and Burgeo Bank (Brian MacLean, BIO) (Cruise 73-006). The purpose was to obtain bottom samples and echogram coverage to aid in the production of a surficial geological map of the area. A total of 305 bottom sample stations and 22 camera stations were made. In addition, 3,750 km of echo sounding for geological interpretation were run.

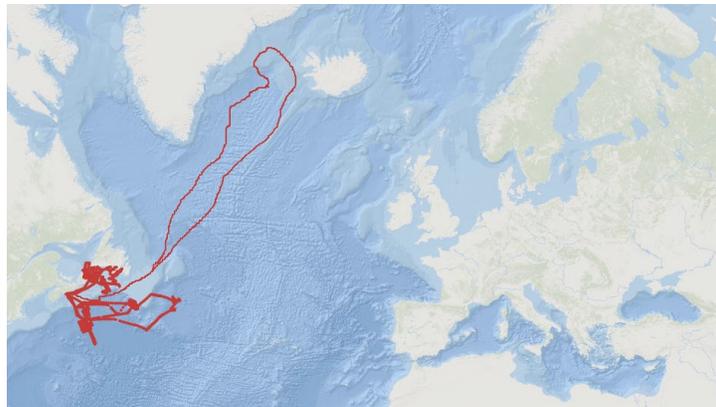
This was followed by another geophysical cruise to the continental margin off Nova Scotia and the Grand Banks which was broken into two legs (Charlotte Keen, BIO) (Cruise 73-011). The purpose was to map changes in the thickness of crustal layers at the continental margin and determine the nature of the transition zone between oceanic and continental crust, look for evidence of transform faulting along the southern margin of the Grand Banks, determine the magnetization of the oceanic basement, investigate the age and origin of the Newfoundland Basin, obtain sediment samples to determine the recent sedimentary history of the continental margin and conduct heat flow measurements. Information collected included 11,112 km of gravity, magnetics and bathymetry, 15 expendable sonobuoy refraction lines, four seismic refraction lines, 12 core stations, four dredge stations, 15 oil tows, two heat flow stations, two sonobuoy magnetometer stations and two camera stations.

Next was another geophysical and geological cruise, this time to the Laurentian Channel, St. Pierre Bank, Burgeo Bank and the Cape Breton Shelf (Lew King, BIO) (Cruise 73-016). The purpose was to obtain a better understanding of Appalachian geology between Nova Scotia and Newfoundland, extend knowledge of Appalachian geology seaward beneath the Atlantic coastal plain, obtain information on the broad structural framework of the area, map the surficial geology of the area and map the sub-Pleistocene bedrock geology of the area. A total of 2,778 km of seismic profiling, 1,481 km of sidescan sonar profiling and 5,556 km of gravity and magnetic profiling were obtained. In addition, 18 bedrock drilling stations, three piston coring stations and three bottom photo stations were occupied. The new electric rock core drill performed extremely well and collected cores on the order of 3-6 m long.

This was followed by a major two-month cruise to the Denmark Strait to participate in Overflow '73, an international physical oceanographic program sponsored by the International Council for the Exploration of the Sea (ICES) which involved 12 ships from six countries (Charlie Ross, BIO) (Cruise 73-025). The overall purpose of this ambitious program was to investigate the overflow of deep water across the Greenland/Scotland ridge system and measure the transport of water from the Norwegian Sea into the North Atlantic through the Denmark Strait. The first phase concentrated on laying 14 current meter moorings and measuring water properties along the mooring lines. The second phase consisted of a CTD Rosette sampler survey of the entire area. The third phase consisted of recovering the moorings and sampling water properties along the mooring

lines. The new Rosette sampler was designed and built at BIO and fitted with 10 PVC water sampling bottles. Water analyses included salinity, oxygen and nutrients. Small-scale temperature, conductivity and velocity measurements were made using Octoprobe, also designed and built at BIO, to study microstructure in the water column. In addition, sediment samples were collected with a boomerang bottom grab and gravity corer. During this cruise *Hudson*, encountered a huge storm and waves damaged the helicopter hanger door.

The final operation of the year was a month-long multidisciplinary cruise to the Scotian Shelf, Gulf Stream and Labrador coast organized by the Dalhousie Institute of Oceanography (Carl Boyd, DAL) (Cruise 73-031). The primary purpose was to provide training in sea-going research for new graduate students. Most of the Dalhousie graduate students and many of the faculty participated.



Available cruise stations/tracks for 1973

1974

David Butler returned as captain for the first cruise but was then replaced by David Deer. Women were employed on *Hudson* for the first time. These included a female deck officer and steward.

Satellite navigation was now interfaced to the ship's log and gyro and a navigation centre set up to contain all navigation equipment. A narrow beam tri-frequency echo-sounding system was installed and the stabilized transducer was fitted through a gate valve so that it could be withdrawn during operations in ice.

Cruises

Captains: David Butler/David Deer

Number of Cruises: 4

Days at Sea: 189

Nautical Miles Steamed (Reported): 34,451

The first cruise of the year was planned to continue the BIO program of developing new equipment and research techniques. However, just before sailing the cruise plan was modified to accommodate an urgent requirement for geological samples from the Mid-Atlantic Ridge. The first leg, organized by the Dalhousie Department of Geology (Fab Aumento, DAL) (Cruise 74-003). The purpose was to survey a site on the fringe of the Ridge which had been proposed for the first deep penetration of oceanic crust as part of the international Deep Sea Drilling Project (DSDP). Work included gravity and piston coring, dredging, heat flow measurements and trials of a digital depth digitizer. At the conclusion of this program, *Hudson* steamed to St. John's, Antigua to exchange scientific staff.

However, the second leg in southern waters was a disaster (Clive Mason, BIO). The intended engineering program included testing the electric rock core drill, acoustic positioning systems, Batfish and a CTD. However, the two main Paxman diesel generators broke down repeatedly resulting in a series of engine room fires which were attributed to broken fuel lines and leaking lubrication oil. As a result, *Hudson* returned to Antigua for work on the generators during which the senior engineer flew to Trinidad to have some replacement parts made. Unfortunately, these repairs were not successful and both generators broke down again the day after leaving Antigua. It was then decided to abort most of the remaining science program and return to BIO after a short return visit to Antigua to put some scientific staff ashore to fly home. The generator problems continued on the return trip. At one point, after the emergency generator had been running for some hours, the heat from its exhaust stack set fire to cabinets at the aft end of the Drawing Office so it had to be shut down. This left *Hudson* dead in the water with Batfish dangling over the stern until the Paxman generators could be brought back on line. During transit on both legs of this cruise, oil tows were carried out and bathymetric data collected for the international GEBCO (General Bathymetric Chart of the Oceans) Program.

Upon return to BIO, a short third leg program was carried out in nearby waters but hampered by bad weather (Dave McKeown, BIO). Fortunately, most of the lost engineering work was able to be carried out later in the year on *Dawson*.

This was followed by a long springtime physical and chemical cruise to the Gulf of St. Lawrence which was divided into two legs (Cruise 74-006). The first leg focused on collecting more physical oceanographic information from the Gulf during the winter season (Mohammed Hassan, BIO). There were also participants from McGill and the University of Quebec at Rimouski. A total of 436 oceanographic stations were occupied throughout the Gulf. In addition, seven current meter moorings, deployed earlier by *Dawson*, were recovered and four new ones were deployed. In contrast to previous winter cruises to the Gulf, ice was not a problem. During the cruise, brief port calls were made to Sept Isles, QC and Sydney, NS and the leg ended in Quebec City, QC.

The second leg was devoted to chemical oceanography (Mike Bowers, BIO) and numerous Quebec universities were also involved. The objectives were to study geochemical processes controlling the distribution and fate of inorganic chemicals, study

the dynamics of chemicals, including mercury, in the Saguenay River, investigate the existence and nature of benthic nepheloid layers in the Laurentian Trough, obtain additional chemical data from Cabot Strait to improve budget calculations for nutrients, trace metals and particles and conduct physical dynamic studies by using Batfish to trace dye released from a barge moored near Les Escoumins, QC.

Next was a geological cruise to the continental margin off Nova Scotia, the Grand Banks and the Newfoundland seamounts organized by the Dalhousie Department of Oceanography (David Piper, DAL) (Cruise 74-021). It included participants from McGill and the Lamont-Doherty Geological Observatory of Columbia University. The primary purpose was to carry out deep water coring and dredging operations for which only *Hudson* had the necessary winch facilities. Work included collecting piston cores in the Laurentian Fan to determine the impact of turbidity currents on sedimentation, dredging the Newfoundland seamounts to recover volcanic material suitable for radiometric dating and geochemical analysis, collecting piston cores from the continental slope to examine late Pleistocene stratigraphy and collecting deep water samples of benthic organisms using box corers, dredges and grabs. Additional work included heat flow measurements, bathymetric and magnetic surveys and collection of phytoplankton and zooplankton samples for various studies. Overall, this cruise was most successful and provided valuable experience for numerous Dalhousie graduate students in oceanography and marine geology. Also participating in this cruise was a contractor who was commissioned by BIO management to carry out a study of the sociological conditions on *Hudson*.

This was followed by a major three and a half-month long geophysical and geological cruise to the eastern Arctic which was broken up into three legs (Cruise 74-026). The specific objectives of the first leg (David Ross, BIO) were to define the extent of continental crust off northern Labrador and Baffin Island, investigate Tertiary basalts on the western Greenland Shelf in conjunction with the Greenland Geological Survey, carry out a regional geophysical survey of northern Baffin Bay and southern Nares Strait, obtain information on the geomorphology and bottom sediments in sounds and fjords in cooperation with industry, carry out a program of rock core drilling in Lancaster Sound, northern Baffin Bay and Davis Strait, carry out a program of seismic measurements and bottom sampling in Barrow Strait to evaluate possible pipeline routes, carry out a program of shallow seismic, sidescan sonar and bottom soundings around Somerset Island using the *Hudson* barge, learn more on the history of the opening of the Labrador Sea – Davis Strait area and finally collect samples of bottom fauna at abyssal depths in the Labrador Sea and Baffin Bay. Work included 12,400 km of bathymetric, gravity and magnetic profiles, 3,200 km of seismic reflection, 32 gravity core stations, 13 electric rock core drill stations, 37 bottom grab stations, 23 camera stations and 3,400 km of shallow seismic profiles. The new UMEL underwater camera system was successfully tested. In addition, 30 oil tows were carried out. At the end of this leg, a port call was made to Thule, Greenland to exchange personnel.

The specific objectives of the second leg (Bernie Pelletier, BIO) were to determine the crustal structure of Lancaster Sound, define the extent of oceanic crust off the western

side of Baffin Island, conduct a detailed magnetic survey in central Baffin Bay, determine the crustal structure of Davis Strait, obtain sediment cores to study the post-Pleistocene history of Baffin Bay, obtain bottom samples for studying contemporary sedimentary processes, obtain shallow seismic reflection profiles along eastern Baffin Island to explore glacial action and to collect benthic invertebrates in Baffin Bay. Work underway included 7,708 km of gravity profiles, 5,080 km of magnetic profiles, 7,805 km of bathymetric profiles and 965 km of seismic profiles. Station work included 11 gravity cores, seven piston cores, 29 bottom grabs, 12 deep dredge tows and 16 plankton tows. This leg ended with anchoring off Frobisher Bay, NWT to exchange personnel by launch.

The specific objectives of the third leg (Shiri Srivastava, BIO) included a reconnaissance geophysical survey of Davis Strait to determine subsurface structure, drilling on the continental shelf off southern Baffin Island to collect bedrock samples for stratigraphic studies, collecting sediment cores across the mid-Labrador Sea Canyon to determine sediment transport processes, a reconnaissance geophysical survey of the southwestern Greenland continental margin to determine subsurface structure, a detailed geophysical survey in the southeastern Labrador Sea to determine subsurface structure and magnetic anomalies, dredging over the mid-Labrador Sea Ridge for age determination and long piston cores in the Labrador Sea to determine sedimentation rates. Oil and plankton tows were also carried out. Port calls were made at Godthaab, Greenland and Frobisher Bay, NWT for personnel exchange before returning to BIO in late October.



Available cruise stations/tracks for 1974

1975

At the start of the year, *Hudson* underwent a major refit. The ship's bridge was widened and fully enclosed to provide a better view of over-the-side operations and reduce the operating fatigue for watch standers. In addition, the deck slope was reduced in the

bridge and drawing office and a heavy duty Pengo winch was installed on the port side of the foredeck just forward of the bridge.

Cruises

Captain: David Deer

Number of Cruises: 3

Days at Sea: 170

Nautical Miles Steamed (Estimated): 27,030

The first cruise of the year was a two-week engineering venture to the Sargasso Sea south of Bermuda in the early spring (Clive Mason, BIO) (Cruise 75-006). This was again to test at sea new equipment and research techniques under development. These included acoustic positioning trials, Batfish, the new Guildline digital CTD system and the Kiel University Multisonde. Also on board were participants from Guildline Instruments, Kiel University, the India National Institute of Oceanography and the German Forshungsanstalt für Wasserschall und Geophysik. The acoustic positioning system used bottom-mounted transponders to position the ship and deployed instrumentation relative to the transponder array. The new configuration of Batfish, which now included a CTD and fluorometer, was successfully tested. The collaborative work with German scientists was part of the Canadian-German Science and Technology Agreement. Various other items of equipment were also tested and surface oil tows were carried out while underway. During this cruise, ship's personnel produced an edition of the ship's newsletter entitled *Hudsonite* which included articles on the scientific program and Henry Hudson. Numerous future editions were published on subsequent cruises during this era.

This was followed by another engineering cruise to Emerald Basin on the Scotian Shelf (Dave McKeown, BIO) (Cruise 75-007). The primary objective was to examine a small area of Emerald Basin where pockmarks are widespread using sidescan sonar, high resolution seismics and precise navigation. This year marked the beginning of a multi-year program with Hunttec ('70) Ltd. to develop an automatic seabed sediment recognition and charting system (Seabed I Project) and so a secondary objective was to collect seismic data in an area of well-defined geology to establish suitable signal processing and data display techniques. Additional objectives included further testing of the sidescan sonar system, high resolution seismic system, airgun seismic system, Loran-C navigation system, shipboard gravimeter and the newly installed Pengo winch. Participants from Hunttec ('70) Ltd. and the India National Institute of Oceanography were also on board. All the goals were achieved to some extent even though the program was interrupted when the ship had to return unexpectedly to transfer some sick personnel ashore.

Next was a six-month geological cruise which was broken into five legs (Cruise 75-009). The first leg was carried out in the area east of the Avalon Peninsula out to the Flemish Cap (Gordon Fader, BIO). The purpose was to obtain a better understanding of the Appalachian geology of the Avalon Platform and Flemish Cap, obtain further information on the broad structural framework of the area and develop an integrated survey concept

for mapping surficial geology. A total of 9,280 km of gravity and magnetic profiles, 4,900 km of airgun seismic reflection profiles, 3,570 km of Hunttec deep tow high resolution seismic reflection profiles and 1,574 km of sidescan sonar profiling were collected. In addition, 28 electric rock core drill stations, eight Vibracorer stations, one dredge station, 14 van Veen grab stations, 20 camera stations and two gravity core stations were carried out. The results contributed to the ongoing project to develop sediment and bedrock maps of the Grand Banks and adjacent areas. At the completion of the program, *Hudson* steamed to St. John's, NL to exchange personnel.

The second leg was to the Newfoundland Basin and margins of the Grand Banks (Charlotte Keen, BIO). The primary objectives were to obtain high quality seismic reflection data over the eastern margin of the Grand Banks, define the positions and morphology of the Newfoundland seamounts, conduct magnetic and bathymetric surveys of the seamounts, sample material from the seamounts to determine their origin and age, using standard tools carry out a detailed geophysical survey of the Newfoundland Basin, correlate the magnetic anomalies observed in the Newfoundland Basin with those found elsewhere to determine its age and collect piston cores to investigate the late glacial history of the Grand Banks. Data collected included 11,857 km of gravity, magnetics and bathymetry, 3,072 km of seismic reflection profiling and 20 expendable sonobuoy refraction lines. In addition, ten dredge stations, nine core stations and one buoy magnetometer stations were carried out.

The third leg was to the Gulf of St. Lawrence and the continental shelf northeast of Newfoundland (Richard Haworth, BIO). This was divided into two parts with a personnel change in Lewisporte, NL. Objectives included testing the Geomatics magnetic gradiometer along a line on the Scotian Shelf, carrying out seismic reflection and Hunttec surveys in the Cabot Strait, conducting a routine seismic survey in the Gulf of St. Lawrence and collecting samples of bedrock with the electric rock core drill at promising locations. The data collected allowed the preparation of a preliminary geological map of the Gulf. After passing through the Strait of Belle Isle and exchanging personnel by launch in Lewisporte, NL, a gravity, magnetic and seismic survey was conducted on the continental shelf off the northeast coast of Newfoundland. The seismic work included both the airgun and Hunttec deep tow high resolution systems. All planned survey lines were completed and drilling was carried out at various locations. On the basis of the data collected, a preliminary geological map of the area was completed. Overall, data collected included 8,940 km of gravity and magnetics, 4,900 km of seismic reflection, 6,000 km of gradiometer, 23 rock core drills and 15 oil tows. At the completion of the program, *Hudson* steamed to St. John's, NL for personnel exchange.

The fourth leg was to the Labrador Sea and Davis Strait (R. Fillon, BIO). The purpose was to obtain a suite of long piston cores, obtain core samples from the North Atlantic Mid Ocean Channel (NAMOC) for McGill University, determine the rates and frequency of climatic, oceanographic and glacial change throughout the late Pleistocene and to determine periods of activity in the NAMOC and processes involved in its formation. Data obtained included 57 cores, 4,860 km of gravity, magnetics and bathymetry, 100 km of airgun seismics, one dredge station, two camera stations and one plankton tow station.

One core was 14.7 m long, the longest ever taken in the Labrador Sea. Almost a week was lost at the start due to problems with the Pengo winch used for coring. This leg terminated in Frobisher Bay, NWT.

The final leg was also to the Labrador Sea and Davis Strait (S. Srivastava, BIO). The objectives were to collect gravity, magnetic and seismic reflection data in the northern Labrador Sea and southern Davis Strait to delineate the subsurface structure, drill on the continental shelf off southern Baffin Island to get bedrock samples for stratigraphic studies, carry out seismic refraction work in the Labrador Sea using expendable sonobuoys to determine the velocity of sediments and basement rocks, carry out a reconnaissance geophysical survey across the southwestern Greenland continental margin to determine the subsurface structure and collect gravity, magnetic and seismic reflection data in the southern Labrador Sea to delineate fracture zones. All these objectives were met. In addition, twelve oil tows were made and grab samples and photographs were taken at some of the drill stations. Port calls were made in Greenland at Godthaab and Julianehaab. While in Godthaab, a reception was held for local dignitaries. The use of plastic bags on *Hudson* to dispose of garbage in the open ocean was found by staff to be most objectionable.



Available cruise stations/tracks for 1975

1976

The Department of Environment was renamed the Department of Fisheries and Environment.

Seamounts on the Mid-Atlantic Ridge were named after Walter Kettle and Jack Vieau, two previous captains of *Hudson*.

Cruises

Captains: David Deer/Cornelius DeVries/Loran Strum

Number of Cruises: 8

Days at Sea: 156

Nautical Miles Steamed (Estimated): 24,804

The first cruise of the year was a late winter trip to the Labrador Sea for physical oceanographic studies (Allyn Clarke, BIO) (Cruise 76-002). It was designed as a test cruise for a larger operation planned for 1978. The long-term objectives of this program were to provide data and understanding of the West Greenland and Labrador currents throughout the year, determine their volume transports and connections with the atmosphere, estimate the volume of Labrador Sea Water formed in a typical winter and make sensible predictions of its formation during other winters. The specific objectives of this initial cruise were to place current meter moorings and conduct a hydrographic survey in the Labrador Current, use *Batfish* in the central Labrador Sea to explore for possible deep convection events, deploy veined neutrally-buoyant floats in a deep convection event if one was found and measure nutrient, oxygen and stable isotope concentrations in the Labrador Current and Sea. Partway through a port call was made to St. John's, NL. The cruise was most successful and demonstrated that *Hudson* could carry out an effective program in the Labrador Sea during the winter despite the adverse weather conditions, a fitting testimony to both the ship and her officers and crew.

During this cruise, *Hudson* encountered a severe storm which smashed the windows of the Officers Lounge. The Lounge was flooded and emergency repairs were needed. The windows were later replaced with smaller portholes. On the way home, *Hudson* rescued all 18 crew members from the Fisheries patrol vessel *Cape Freels* off Newfoundland. During gale force winds and blizzard-like conditions, the *Cape Freels* caught fire and began taking water through the portholes. The crew was forced to abandon ship into the lifeboats. Fortunately, *Hudson* was nearby and immediately responded to the distress call, rescuing the crew from certain peril.

The next cruise was to the St. Lawrence Estuary and Saguenay Fjord for further chemical studies (Mike Bewers, BIO) (Cruise 76-006). The primary purpose was to complete a study initiated in 1974 of trace metal transport and behavior in the St. Lawrence Estuary at the time of high spring runoff. In addition, some hypotheses concerning trace metal behaviour were tested in the Saguenay Fjord. Sampling was done with a rosette equipped with a CTD, optical transmissometer and Niskin bottles. There were also participants from Dalhousie and McGill universities. The cruise terminated in Quebec City, QC.

Beginning in Quebec City, the next cruise carried out various studies in the St. Lawrence Estuary and Gulf of St. Lawrence led by McGill University (Max Dunbar, McGill) (Cruise 76-008). In addition to the McGill program, navigation studies were carried out by BIO staff. These included comparing the performance of three Loran-C receivers, testing new Loran-C software, evaluating three versions of Canadian Marconi Doppler satellite processing software, evaluating the performance of the Sperry Doppler log in various sea states and simultaneously recording Doppler log, gyrocompass, Loran-C

ranges and raw satellite navigation data to use in the development of the new BIO Navigation (BIONAV) system.

This was followed by an engineering cruise to Emerald Bank and the continental shelf break (Dave McKeown, BIO) (Cruise 76-013). Participants from Dalhousie and the University of Kiel were on board. The general purpose was to assess the accuracy, precision, resolution and reliability of equipment under development. Specific objectives included establishing the movement of a current meter mooring during deployment and recovery, evaluating the performance of a hull-mounted short baseline positioning system, studying the behaviour of Hong Kong trawl doors under tow, comparing Guildline analogue and digital CTDs, carrying out a survey across the shelf with the Kiel Multisonde, collecting box and piston cores, testing a pair of ocean bottom seismometers, testing the rebuilt BIO sidescan sonar system, conducting Batfish trials, obtaining CTD data along the Halifax Section, laying an experimental Kevlar mooring, testing the Pengo winch, testing a number of pingers and ensuring the narrow beam sounder was functioning properly. Except for problems with the Pengo winch, the cruise was most successful.

Next was a geological cruise to the Gulf of Maine which was primarily of a development nature (Lew King, BIO) (Cruise 76-016). The main objectives were to use the Huntec Deep Tow high resolution seismic system (DTS) and the BIO sidescan sonar system to select drill sites, obtain bedrock samples with the electric rock core drill, conduct studies related to acoustic positioning and collect piston cores. Participants from Huntec '70, Nordco, Memorial University and the US Naval Oceanographic Office were also on board. A total of 1,350 km of bathymetric, seismic reflection and sidescan sonar profiling was carried out and 17 rock core drill, six piston core and 12 bottom photo stations were successfully occupied.

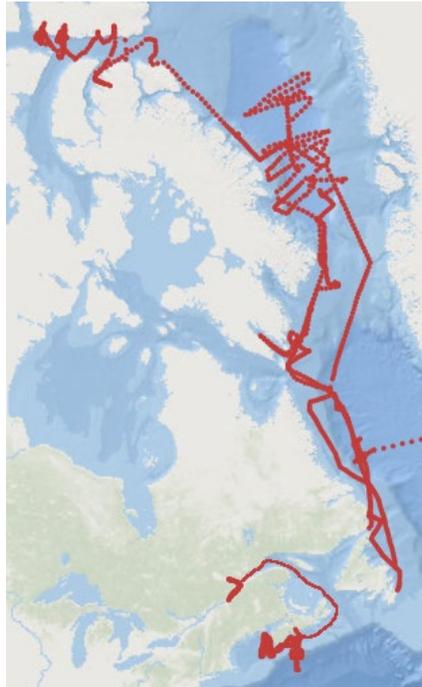
Next was a joint physical and biological cruise to the Scotian Shelf and Slope (Peter Smith, BIO) (Cruise 76-020). The overall goal was to study the physical and biological characteristics of the shelf break region between 62° and 64° W. The specific objectives included recovering current meter moorings deployed earlier, deploying new ones, running a coarse CTD grid from the shelf to the southern edge of the slope water boundary, surveying the slope water boundary and shelf break region with Batfish equipped with a CTD and fluorometer and carrying out a set of intensive measurements of parameters related to the primary production system. A total of 77 CTD casts, 167 Batfish tows and 112 biological stations using a rosette sampler were successfully completed.

Following was a geophysical cruise to the Labrador Shelf, Davis Strait, Baffin Bay and Lancaster Sound (Robin Falconer, BIO) (Cruise 76-023). The primary objectives were to study the margins of Baffin Bay with geophysical techniques and extend earlier studies of the crustal structure of the central Baffin Bay. Secondary objectives included extending geophysical studies of the northern Labrador Sea, conducting a geophysical survey on the Labrador Shelf, comparing the performance of different navigation systems on the Labrador Shelf, initiating chemical oceanographic studies in Lancaster Sound,

conducting studies in Lancaster Sound under contract to the Defence Research Establishment Pacific (DREP) and observing seabirds. Extensive bathymetric, gravity, magnetic, sidescan and both reflective and refractive seismic profiling surveys were carried out. In addition, numerous dredge and piston cores were collected, oil tows conducted and bottle cast stations occupied. Other participating agencies included the Geological Survey of Canada (GSC) Terrain Sciences Division from Ottawa, the Canadian Wildlife Service (CWS), Dalhousie University, Huntec Ltd., Compagnie Francais du Petrole and the Greenland Geological Survey. There was also a newspaper reporter on board. Port calls were made at Saglek, Labrador, Holsteinsborg, Greenland and Thule, Greenland to exchange personnel.

Unfortunately, near the end of the cruise, while *Hudson* was attempting to smash through a ridge of ice between Somerset and Prince Leopold islands while doing a seabird survey, the starboard propeller came off its shaft and was lost. Divers from a nearby Navy base were soon on the scene and reported that the propeller shaft appeared to be fine. They said it was possible to install a new propeller under water but unfortunately there was not a spare one on board. With the aid of the *John A. MacDonald*, *Hudson* was freed from the ice and proceeded slowly to nearby Maxwell Bay, NWT where the cruise terminated. Personnel were exchanged using Twin Otter flights from Resolute.

Consideration was given to flying the spare propeller at BIO to Thule, Greenland and installing it there but it was soon decided that this was not feasible and to proceed with the next scheduled cruise with just one propeller, working under reduced power and speed and avoiding all sea ice. This was a geophysical and geological cruise to Lancaster Sound (Mike Lewis, GSC Ottawa) (Cruise 76-025). Departing from Maxwell Bay, the program had to be adjusted at the last moment due to the loss of the propeller and the work planned for Barrow Strait had to be canceled due to severe ice conditions. The primary objectives in Lancaster Sound and adjacent inlets were to determine the distribution of surficial sediment types, determine the presence and intensity of ice scouring and rafting, measure bottom temperatures and sediment thermal gradients, determine offshore bedrock structure by seismic, magnetic and gravity profiling, map near shore sediment facies by sampling, sidescan sonar and Scuba diving, measure seismic velocities and structure in nearshore areas by shallow refraction methods, measure physical properties of offshore sediments by bottom seismic array, neutron and gamma probes, core a variety of offshore sediment types, determine acoustic propagation properties of seawater and sediments and evaluate Differential Omega as a positioning tool. Data collected included 4,500 km of bathymetric, gravity and magnetic profiles, 1,790 km of seismic reflection, 300 km of sidescan sonar, 19 piston cores, 21 gravity cores, 29 bottom grabs, 14 CTD stations, 23 camera stations and 12 thermal probe stations. Diving was supported using the ship's launches. On the way south after the program was completed, *Hudson* stopped in Scott Inlet to observe an oil slick but, because of ice conditions, it was not possible to locate its source and determine its extent. She then steamed to St. John's, NL for dry docking and replacement of the lost propeller. It was later concluded that the propeller was lost because it had not been properly re-installed after the last dry docking. When repairs were completed, *Hudson* returned to BIO for the winter.



Available cruise stations/tracks for 1976

1977

Canada's Extended Economic Zone (EEZ), which included exclusive fisheries and seabed resource jurisdiction, was increased to 370 km.

Over the winter, the old console area aft of the Drawing Office was completely refurbished. Major improvements were also made to the A-frame on the stern and the winch room on the upper deck below the bridge.

Cruises

Captains: David Deer/Loran Strum

Number of Cruises: 9

Days at Sea: 166

Nautical Miles Steamed (Estimated): 26,394

The first cruise of the year was an engineering cruise to the Scotian Shelf (Dave McKeown, BIO) (Cruise 77-005). Participants were also on board from Huntce and Kiel University. The overall purpose was further testing of various oceanographic instruments and techniques being developed at BIO. Specific objectives included testing the multiparameter CTD system, comparing data obtained with the multiparameter CTD and Kiel Multisonde, testing the computing deck unit for analogue CTDs, establishing the accuracy of the short baseline system, obtaining seismic, noise and towing characteristic

data with the Hunttec deep tow system (DTS), testing various methods for obtaining bedrock with the electric rock core drill, further testing on the towing characteristics of Batfish and testing various modules of the BIONAV system at sea. Specific operations were carried out in Emerald Basin, on Roseway Bank and at the shelf break. Most of the objectives of the cruise were achieved.

This was immediately followed by a biological cruise on the Scotian Shelf and Slope (Alex Herman, BIO) (Cruise 77-007). The general purpose was to incorporate several biological programs into a joint study of the productive slope waters off the Scotian Shelf. The five primary operations were CTD Rosette casts for chlorophyll, nutrient and oxygen determination, plankton tows using opening and closing nets, acoustic surveys of zooplankton layers, Batfish tows equipped with a CTD and fluorometer and measuring fluorescence of seawater sampled with a new pumping system which collected seawater from a near surface input port close to the bow through chemically inert, non-metallic piping. Incubation experiments were also carried out. The overall program was most successful.

Next was a geophysical and geological cruise to the Grand Banks and Flemish Cap (Lew King/Gordon Fader, BIO) (Cruise 77-011). The purpose was to obtain bedrock samples using the electric rock core drill, obtain Hunttec Deep Tow (DTS) high resolution seismic, airgun, magnetic and sidescan sonar data in support of surficial and bedrock mapping programs and assess the potential for Loran-C navigation on the Grand Banks. Data collected included 2,450 km of seismic reflection airgun profiling, 1,850 km of seismic reflection Hunttec DTS profiling, 600 km of sidescan profiling, 2,450 km of bathymetric and magnetic profiling, 58 drilling stations, 20 bottom photo stations and 12 bottom grabs. The cruise objectives were met with various degrees of success. The rock core drill worked well but there were problems with the sidescan sonar and Hunttec systems. Nonetheless, significant data were obtained concerning the extent and nature of seabed scouring by icebergs. The cruise ended in St. John's, NL.

This was followed by a geophysical cruise to the continental margin off the northeastern Grand Banks (Charlotte Keen, BIO) (Cruise 77-014). The objectives included measuring the velocity structure of the earth's crust using seismic refraction methods, using the new BIO ocean bottom seismometers (OBSs) as part of the refraction experiments, obtaining underway geophysical measurements and collecting piston cores. This was the first time that OBSs were used under operational conditions. Data collected included 3,489 km of wide-beam bathymetry, 1,420 km of narrow-beam bathymetry, 4,811 km of gravity profiles, 3,489 km of magnetic profiles, 1,129 km of seismic reflection profiles, 24 expendable sonobuoy stations, six OBS stations, nine cores and two sound velocimeter stations. With few exceptions, all equipment worked well. In particular, the Loran-C navigation allowed an improvement in the precision of positioning the ship over gear on the seabed.

Next was a short engineering cruise to Sambro Bank for equipment testing and evaluation (Peter Kingston, BIO) (Cruise 77-018). The prime purpose was testing a new version of

the electric rock core drill with a larger diameter barrel in order to collect unconsolidated material above the bedrock as well as the bedrock itself. Other gear was tested as well.

This was followed by a geological cruise to the Labrador Shelf and Saglek Bank to investigate the glacial history of this region (Richard Fillon, BIO) (Cruise 77-021). The prime objective was to define the geology of surficial sediments on the Labrador shelf and unravel their glacial history. Numerous other related peripheral projects were also carried out, some for non-BIO colleagues. Data collection included Hunttec DTS surveys, sidescan sonar surveys, rock dredging, oil tows, coring, sonobuoy and airgun seismic surveys, magnetic and gravity surveys, bathymetric surveys for GEBCO, sea bird surveys, grab samples and bottom photos. The cruise was judged to be an unqualified success.

This was followed by a late summer chemical oceanography cruise to the Labrador Sea, Baffin Bay, Davis Strait, Lancaster Sound, Jones Sound and Smith Sound (Peter Jones, BIO) (Cruise 77-024). This was the first *Hudson* cruise to the eastern Arctic devoted to studying the chemical oceanography of this large unstudied area. The information collected was essential to begin understanding the impacts of expected economic development in this region, in particular oil and gas. The main purposes were to study chemical constituents and transport in the eastern Arctic, to determine chemical baseline levels and to further investigate the oil seep near Scott Inlet. In addition, gaps were filled in previous BIO gravity and magnetic surveys. Samples were collected from the sea surface layer, water column and sediments while the ship was on station. Most water column samples were taken with Niskin bottles mounted on a rosette fitted with a CTD and oxygen sensor while sediment samples were collected by various grabs and corers. Oil tows and geophysical data were collected while underway. Chemical variables measured included salinity, oxygen, alkalinity, dissolved hydrocarbons, nutrients, chlorophyll, tritium, trace elements, dissolved inorganic carbon and particulate organic carbon. In addition some plankton tows were made to study phytoplankton and foraminifera. Most shipboard operations followed standard procedures so that the results could be compared to those from other regions. It was determined that the oil slick near Scott Inlet was the result of natural seepage, possibly from truncated sedimentary rock strata that were observed in the submerged walls of the Inlet. However, because of ice conditions at the time, the exact location of the source and its extent could not be determined. During this long cruise, ship's staff produced another edition of the *Hudsonite* which contained a number of articles on the scientific program along with various cartoons and puzzles. The cruise terminated at Thule, Greenland.



CSS Hudson in northern Canada (Credit BIO Photo Unit)

Next was a geophysical and geological cruise to the Baffin Island continental shelf (Brian MacLean, BIO) (Cruise 77-027). Participants were also onboard from Dalhousie and Hunttec. The primary objectives were to conduct seismic reflection, gravity and magnetic surveys to delineate bedrock units and stratigraphic and structural relationships, obtain bedrock core samples by shallow drilling, carry out a reconnaissance geophysical survey across Baffin Bay enroute to Thule, Greenland and across Davis Strait enroute to and from Holsteinborg, Greenland to obtain seismic refraction profiles using expendable sonobuoys and obtain reconnaissance data on surficial sediments by means of sampling by piston cores and grabs and acoustic systems. Secondary objectives included compiling bathymetric data, investigating the distribution of sediment micro- and macrofauna and further testing of an underwater acoustic positioning system. The ice conditions along the coast of Baffin Island between Clyde and Cumberland Sound were unusually bad which impeded tow and drilling operations. Partway through the cruise a short port call for crew rest was made at Holsteinsborg, Greenland and a reception for local dignitaries was held on board. The cruise terminated at Frobisher Bay, NWT. Adverse weather and tidal conditions at the landing pier were extremely challenging. Overall, the cruise was most successful.

The final cruise of the year was to the Labrador Shelf and Slope (John Lazier, BIO) (Cruise 77-029). There were also participants on board from the Canadian Wildlife Service (CWS) and NORDCO Ltd. The objectives included placing five current meter and thermistor chain moorings across Nain Bank and the outer slope, conducting 125 CTD casts with a rosette sampler on thirteen lines across the Labrador Shelf from Frobisher Bay to the Strait of Belle Isle, measuring oxygen, salinity and nutrient concentrations in seawater, collecting phytoplankton and zooplankton, measuring primary productivity, collecting seabird data, conducting a sidescan sonar survey on Saglek Bank and further testing of the Satnav and Loran-C navigation software. After departing BIO in late July, *Hudson* returned home after being away for over three months up north.



Available cruise stations/tracks for 1977

1978

Bill Ford retired as Regional Director General and was replaced by Ced Mann. The management responsibility for BIO research vessels continued to be under the direction of a sea-going oceanographer.

C. Anthony Law, an accomplished Halifax artist, participated in an arctic cruise on *Hudson* and created a painting of the ship along the coast of Baffin Island. This painting was donated to BIO and has hung just inside the main entrance of BIO for many years. It also now graces the cover of *Voyage of Discovery*, the book commemorating the 50th anniversary of BIO.

Work on BIONAV, the general purpose logging system to provide common time throughout the ship as well as to log navigation, magnetic and gravity data, was progressing well and the system was proving to be an asset to *Hudson's* navigational requirements.

Cruises

Captains: David Deer/Loran Strum

Number of Cruises: 9

Days at Sea: 238

Nautical Miles Steamed (Estimated): 37,842

The first cruise was an ambitious three-month venture to the Labrador Sea for further physical oceanographic studies (John Lazier/Allyn Clarke, BIO) (Cruise 78-002). This was broken up into five legs. The purpose of the first leg was to recover and lay current meter moorings in the Labrador Current over the Labrador Shelf and Slope, complete a line of CTD stations across the central Labrador Sea and place three current meter moorings south of Cape Farewell to measure the flow of the East Greenland Current. The purpose of the second leg was to conduct a CTD survey in the southeastern part of the Labrador Sea to investigate the offshore flow of the Labrador Current and the influence of the Atlantic Current. The purpose of the third leg was to investigate the formation of Labrador Sea water through winter cooling and subsequent mixing and deep convection using a current meter array, free drifting vertical current meters and CTD observations as well as further development of the BIONAV system. The purpose of the fourth leg was to occupy the Cape Farewell-Flemish Cap-Grand Banks line to provide CTD data on open boundary conditions for a numerical model of the Labrador Sea and to recover the Cape Farewell current meter moorings. The objective of the final leg, carried out in July, was to recover all moorings left on the Labrador Shelf and Slope. Seabird surveys were also carried out. The ship experienced severe icing during Leg 3, especially on the foredeck and to a lesser degree on the quarterdeck. As a result, deck equipment was unusable for varying lengths of time and electrical and hydraulic systems were damaged. Due to heavy iceberg damage, 60% of the major components of the current meter moorings on the Labrador Slope and Slope were unfortunately lost. Many lessons were learned about deploying current meter moorings in ice-infested waters.

Next was an engineering cruise to the Scotian Shelf, Laurentian Channel and Placentia Bay (Dave McKeown, BIO) (Cruise 78-008). The main objective was again to test various oceanographic instruments and techniques under development at BIO. These included the multiparameter CTD, an acoustic bottom sensor, Batfish, an impact cone penetrometer, the Hunttec Deep Tow System (DTS), the AGC sidescan sonar system, the electric rock core drill, BIONAV, acoustic positioning systems and new data transmission and logging formats. In addition, personnel from the newly established Marine Fish Division at BIO were trained in the use of Batfish. The cruise terminated in St. John's, NL.

This was followed by a cruise to Placentia Bay organized by Memorial University (G. Peters, MUN) (Cruise 78-012). This was their first use of *Hudson*. The main purpose was to obtain data on marine sediments in order to relate acoustic measurements to conventional sampling techniques. Another objective was to test a prototype penetrometer under development. After a broad survey using the Hunttec DTS, sidescan sonar and airgun seismics, six locations were selected for intensive study. Apparently the survey lines were determined by where the best satellite TV coverage of the NHL playoffs could be obtained! In total, 1,027 km of Hunttec DTS, sidescan and bathymetry data were collected as well as 250 km of airgun seismic reflection profiles. In addition, 31 piston cores, 92 van Veen grabs and 17 camera stations were taken. The penetrometer was tested 20 times. This cruise consisted of many interlocking complementary parts and involved a multidisciplinary staff from three institutions. Overall it was a very successful

undertaking and essentially all objectives were obtained. The cruise terminated in St. John's, NL.

Next was a chemical oceanography cruise to the western North Atlantic during June which departed from St. John's (Mike Bowers, BIO) (Cruise 78-016). The primary objectives were to determine the presence and extent of previously reported chemical anomalies in the deep water between the Newfoundland Shelf and the Mid-Atlantic Ridge that were believed to be related to hydrothermal or volcanic activity and to conduct oceanic baseline measurements of several trace metals. Other activities included geophysical investigations of the Gibbs Fracture Zone, geological programs by Dalhousie, McMaster and the University of Rhode Island, working on the ship's navigation systems, tracking a Norwegian surface transponding buoy and occupying a station proposed by the Intergovernmental Oceanographic Commission (IOC) as a deep ocean pollution monitoring station. Chemical variables measured included iron, manganese, copper, zinc, nickel, cadmium, cobalt, mercury, helium, tritium, silicate, phosphate and nitrate. Seabird distribution data were also collected by the Canadian Wildlife Service (CWS) as part of the PIROP program (Programme Intégré de recherches sur les oiseaux pélagiques). Despite some winch problems, the cruise was quite successful.

This was followed by a geophysical cruise to the continental margin off Nova Scotia, Orphan Knoll Basin and the Labrador Shelf (Charlotte Keen, BIO) (Cruise 78-020). There were also participants on board from the Canadian Wildlife Service (CWS) and NORDCO Ltd. Immediately after departing BIO, *Hudson* proceeded to the Bedford Magazine to load 17 tons of explosives for the seismic work. The objectives were to examine the crustal structure across the Nova Scotian continental margin by using high quality seismic refraction techniques and ocean bottom seismometers, complete the seismic refraction studies in Orphan Knoll Basin started last year, collect gravity, magnetic and seismic reflection data to complement the seismic refraction results, dredge pinnacles on Orphan Knoll, recover current meter moorings deployed earlier on the Labrador Shelf and collect piston cores at the entrance to Makkovik Bay, NL. Data collected included 3,658 km of wide beam bathymetry, 3,448 km of narrow beam bathymetry, 3,577 km of gravity profiles, 2,566 km of magnetic profiles, 555 km of seismic reflection profiles, 20 expendable sonobuoy stations, ten ocean bottom seismometer stations, two dredge stations and two piston cores. In addition, nine current meter moorings were successfully recovered. Partway through a port call was made in Nain, NL to exchange personnel. The cruise terminated in St. Anthony, NL.

This was followed by a geophysical and geological cruise to the northeast Newfoundland Shelf (Richard Haworth, BIO) (Cruise 78-023). The prime purpose was to collect data to be used in producing a surficial geological map for the region. This involved using the electric rock core drill to sample bedrock and piston cores to sample unconsolidated sediments to prove the existence of geological units previously inferred from geophysical observations. In addition, gravity, magnetic and seismic profiling was carried out at numerous locations. The weather was superb and the cruise was considered a great success.

Next was a chemical oceanography cruise which returned to Scott Inlet, Buchan Gulf, Lancaster Sound and the North Water (Eric Levy, BIO) (Cruise 78-026). Data collected by *Hudson* the previous year provided strong evidence that the oil slick first observed off Scott Inlet on the east coast of Baffin Island in 1976 was the result of natural seepage from the seabed. The prime purpose of this return visit was to determine the exact location of the seepage, its chemical composition and its rates of escape from the seabed and dispersal in the marine environment. A second objective was to use the seep as a natural laboratory for studying the effects of low levels of petroleum on arctic biota. Water samples were collected using a variety of samplers for the analysis of salinity, dissolved oxygen, dissolved light hydrocarbons, dissolved and dispersed petroleum residues, nutrients, oil degrading bacteria and measurements of productivity. Samples for trace metal analysis were also collected at some stations. Surficial sediments were collected by grab for estimation of petroleum concentration and analysis of benthic fauna. When the ship was underway, magnetic, gravity and bathymetry measurements were made whenever ice conditions permitted. In addition, bird counts and visual observations of oil slicks were made several times a day. There were also participants on board from Bowdoin College who conducted experiments on the biological effects of the observed hydrocarbon concentrations. Stations were also occupied in Buchan Gulf, the mouth of Lancaster Sound and the North Water enroute to Thule, Greenland where the cruise terminated.

This was immediately followed by a geophysical cruise to the Baffin Island Shelf and Baffin Bay which departed from Thule (Brian MacLean, BIO) (Cruise 78-029). The main objectives were to continue extending geological and geophysical investigations of the nature, regional distribution and structure of the rocks underlying the Baffin Island shelf with emphasis on Scott Inlet, Buchan Gulf and Cape Dyer-Resolution Island areas together with reconnaissance of the shelf between Scott Inlet and Cape Dyer as well as collection of reconnaissance data on unconsolidated sediments in those areas. As part of the Scott Inlet studies, it was intended to examine possible relationships between seabed formations and the observed oil slick. In addition, a brief study was undertaken of the natural seismicity of Baffin Bay in conjunction with land-based seismograph stations. The bedrock investigations involved collection of data with seismic reflection, sonobuoy refraction, magnetometer, gravity meter and Hunttec deep tow systems. Samples of bedrock were obtained with the BIO electric rock core drill and dredge. Data on unconsolidated sediments were collected by continuous seismic reflection, Hunttec DTS and sidescan sonar systems along with samples obtained by piston coring, Vibracoring, grabbing and photographic operations were also carried out. Natural seismic events in Baffin Bay were recorded by three BIO ocean bottom seismometers. With just a few exceptions, the cruise objectives were achieved. Rapid freeze-up conditions in northern Baffin Island coastal waters and adjacent Baffin Bay hampered operations. The cruise terminated in St. Anthony, NL

The final cruise of the year was a return visit to Hamilton Bank on the Labrador Shelf (John Lazier, BIO) (Cruise 78-032). The purpose was to deploy three current meter moorings in the Labrador Current and to complete a CTD survey in the vicinity of the

moorings to obtain a synoptic picture of the current at the beginning of the current meter records. To avoid the iceberg damage which affected earlier moorings in this area, current meters were not placed at shallow depths. All objectives were achieved.



Available cruise stations/tracks for 1978

1979

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

The Venture gas field was discovered on Sable Island Bank and was estimated to contain more gas than all other discoveries made to date. Oil was discovered at Hibernia on the Grand Banks.

Ced Mann moved to Institute of Ocean Sciences in Sidney, BC and was replaced as Director General by Alan Longhurst. Again, the management responsibility for BIO research vessels continued to be under a sea-going oceanographer.

After two years of development, BIONAV, the real time navigation display and logging system distributed throughout the ship, was installed on *Hudson* for final testing.

Cruises

Captains: Loran Strum/Fred Mauger

Number of Cruises: 10

Days at Sea: 215

Nautical Miles Steamed (Reported): 21,214

The first cruise of the year was in January to the Flemish Cap to carry out the BIO contribution to the international Flemish Cap Experiment organized by the International Council for North Atlantic Fisheries (ICNAF) which was headquartered at BIO (Charlie Ross, BIO) (Cruise 79-001). The major objectives were to deploy four current meter moorings, launch two satellite-tracked drifting buoys, occupy 133 CTD stations and transmit the daily temperature and salinity data into the Integrated Global Ocean Services System (IGOSS). The cruise ended in St. John's, NL.

This was followed by a lengthy fisheries surveillance cruise to Hamilton Bank which was organized by the newly established Northwest Atlantic Fisheries Centre in St. John's, NL (B. Paul, NAFC) (Cruise 79-00?).

Immediately on return to BIO, *Hudson* was diverted to Cape Breton to help deal with the *Kurdistan* incident, an oil tanker which had just split in two in the Cabot Strait and spilled an estimated 7,000 tons of Bunker C oil in ice-infested water (Ron Trites, BIO). The ship carried out a three-day program of searching for spilled oil and ice-oil mixtures along the southeast shore of Cape Breton using a Coast Guard helicopter, photography, sampling bottles and Neuston nets. Some BIO staff were shuffled back and forth to *Hudson* by helicopter. Several large ice-oil mixtures were observed in offshore waters and it was estimated that these accounted for about one third of the oil spilled.

Next was a biological oceanography cruise to the Scotian Shelf and Slope (Bob Conover, BIO) (Cruise 79-006). The purpose was to conduct ecological studies of plankton production processes during the spring phytoplankton bloom. Emphasis was placed on the spatial and temporal relationships within the plankton community, growth limitation of plant cells by light, uptake and renewal of nutrients and utilization of particulate matter by zooplankton grazers. Sampling equipment used included the newly developed CTD Rosette, the ship-board mounted pumping system, the new Bedford Institute of Oceanography Net and Environment Sensing System (BIONESS), the Longhurst-Hardy Plankton Recorder (LHPR), Batfish and various plankton nets. Acoustics were also used to measure deep layers of zooplankton. While crossing the shelf break area, two patches of weathered oil containing badly oiled seabirds were observed. It was suspected that these may have been the result of the *Kurdistan* oil spill few weeks earlier. Even though the spring plankton bloom had largely disappeared by the time of the cruise, in general the purposes of the cruise were accomplished.

Next was an engineering and geological cruise which was divided into two legs (Cruise 79-011). The first leg was to the Scotian Shelf, Gulf Stream and the Grand Banks for further equipment testing (Dave McKeown, BIO). The program included engineering trials with the Huntec DTS, testing an acoustic altimeter mounted on the CTD over various bottom types, testing a new Guildline low-cost CTD, acoustically positioning a box corer on the seafloor, testing a free-fall current profiler, conducting further sea trials of BIONAV, testing the electric rock core drill in deep water, testing the new Guildline Batfish and deploying a tide gauge on the Grand Banks east of St. John's, NL. Overall the cruise was most successful and terminated in St. John's, NL.

The second leg was a geophysical and geological cruise departing from St. John's to Placentia Bay and the Scotian Shelf (Lew King, BIO). Objectives included obtaining bedrock samples in the approaches to Placentia Bay, obtaining Huntec DTS, airgun and side scan sonar profiles in Placentia Bay, along the south coast of Newfoundland, Laurentian Channel and Emerald Basin, obtaining piston and vibracores in Emerald Basin, testing sidescan sonar in the deep water of the Laurentian Channel, testing a new large diameter electric rock core drill, testing a box corer, testing a battery-powered nephelometer and testing a short baseline positioning system. Sampling operations included 1,600 km of seismic reflection airgun profiling, 2,100 km of seismic reflection Huntec DTS profiling, 1,900 km of sidescan profiling, 2,200 km of bathymetric profiling, six electric rock core drills, nine piston cores, four vibracores, 13 bottom photo stations, five bottom grabs and one box core. All the major cruise objectives were achieved.

This was followed by a geophysical cruise to the Greenland Margin and Labrador Sea which also involved participants from Dalhousie (Shiri Srivastava, BIO) (Cruise 79-013). The main objectives were to collect velocity information of the upper crust, lower crust and mantle off the southwest Greenland margin by carrying out seismic refraction experiments using ocean bottom seismometers (OBSs), expendable sonobuoys, dynamite and airguns, collect gravity, magnetic and seismic reflection data to delineate subsurface structures, collect continuous gravity data along several long traverses through the Labrador Sea in order to adjust old gravity data, evaluate the accuracy and performance of BIONAV and to evaluate the feasibility of displaying graphically geophysical and navigational data in real time using the shipboard minicomputer. Before leaving the harbour, Hudson went up to the DND Bedford Magazine to load explosives for the refraction experiments. Unfortunately, the seismic refraction experiments were not successful due to the loss of three out of four of the OBSs but some very useful shallow refraction data were collected using expendable sonobuoys. Rock samples were collected by dredge and seabed photos were taken with an Edgerton camera. Regular oil tows were collected daily throughout the cruise. BIONAV proved to be a tremendously successful system and contributed a great deal to the success of the cruise. Logging of BIONAV and BIODAL data by the main computer proved to be most successful and allowed the plotting of ship's track and geophysical data within an hour after they were collected. The cruise terminated in St. John's, NL.

Next was a geological cruise to the east Newfoundland Basin and Slope (Charlie Schafer, BIO) (Cruise 79-017). The purpose was to study the benthic boundary layer in a continental slope environment. Sediment samples were collected with a variety of grabs and corers plus a large number of seabed photographs were taken. CTD and bottle cast stations were also occupied. Sediment-organism relationships were examined using X-radiography, geotechnical measurements and Pb-210 profiles. The cruise ended in Lewisporte, NL.

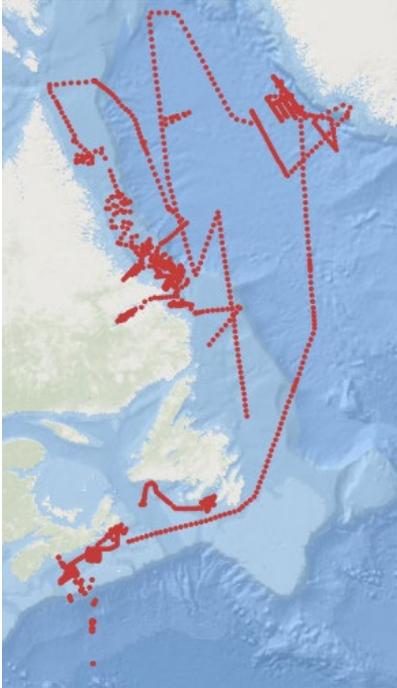
Immediately after was another geological cruise to the Labrador Shelf and Hamilton Inlet (Gus Vilks, BIO) (Cruise 79-018). The purpose was to gather information for a model describing the paleoceanography and paleosedimentation along the margins of the Laurentide Ice Sheet, studying the dynamics of the inner shelf and examining the

distribution of particulate matter in the water column and the geochemical response of marine muds to oxidation states of interstitial water. The spatial distribution of palynological assemblages (pollen, terrestrial spores, dinocysts and diatoms) was also examined. Equipment used included the Hunttec DTS, sidescan sonar, airgun, Guildline CTD mounted on a rosette with bottles and attenuation meter, piston corer, box corer and Vibracorer. All equipment worked very well. In addition, RALPH, a new instrument to study the dynamics of seabed sediments, was given its first sea trials. The cruise ended in Goose Bay, NL.

Next was another geological cruise to various locations along the Labrador Shelf (Richard Fillon, BIO) (Cruise 79-019). The primary objectives were surficial sediment surveys of Harrison, Makkovik and Nain Banks and a study of iceberg dynamics and grounding phenomena. Data collected included 5,556 km of gravity and magnetic profiling, 778 km of side scan sonar, 555 km of Hunttec DTS profiling, 389 km of airgun seismic profiling, 61 grabs, 25 piston cores, four vibracores, four dredges and four camera stations. Eight oil tows were also collected and seabird observations were made. The cruise was most successful and upon completion of the program *Hudson* returned again to Goose Bay, NL.

Next was a short cruise to Hamilton Bank for further physical oceanographic studies (John Lazier, BIO) (Cruise 79-020). The objective was to service three current meter moorings as part of the long-term program to measure the velocity of the Labrador Current. The first was located, interrogated and recovered without difficulty but some components were lost and had to be replaced during redeployment. The second mooring could not be found and was given up as lost due to either icebergs or fishing trawlers. It was not replaced. The third mooring was located, interrogated, released and recovered. It too was replaced. When the program was finished, *Hudson* returned to BIO after an absence of two and a half months.

In September, *Hudson* departed on a month-long cruise to the Gulf Stream and Mid-Atlantic Ridge (Bob Reiniger, BIO) (Cruise 79-025). The purpose was to recover three long-term current meter moorings in the Gulf Stream deployed in 1978 by *Dawson*, run a CTD line down 50°W, do an engineering evaluation experiment with the electric rock core drill on a seamount in the Mid-Atlantic Ridge, place a new array of current meter moorings in the Gulf Stream just off the tail of the Grand Banks, do an engineering evaluation of a current profiling instrument which involved placing two transponder moorings, run a CTD line up 42°15'W and run another CTD line along 39°N. Two moorings were recovered completely and the third was only partially recovered. Two were replaced. A total of 44 CTD stations, 38 XBTs, ten oil tows and six current profiles were successfully occupied. Ten drill stations were attempted and all were successful. A total of 15 m of basalt and limestone was collected. A brief port call was made to Santa Cruz, Flores in the Azores to exchange personnel. When the work was completed, *Hudson* returned to BIO. This was her last cruise of the year.



Available cruise stations/tracks for 1979

1980

The A.G. Huntsman Award was created and an image of *Hudson* was engraved on the medal which has been presented annually every year since to an outstanding scientist from the international marine science community.

Cruises

Captains: Fred Mauger/Loran Strum

Number of Cruises: 8

Days at Sea: 183

Nautical Miles Steamed (Reported): 37,180

The first cruise of the year was a short return visit to the Flemish Cap and Avalon Channel for further physical oceanographic studies as part of the ICNAF Flemish Cap Experiment (Charlie Ross, BIO) (Cruise 80-002). The purpose was retrieve and replace a current meter mooring laid in 1979, collect CTD data around the mooring site, replace a bottom pressure sensor laid in 1979, run a CTD section across the Avalon Channel and check the performance capabilities of three hyperbolic Loran-C receivers. Poor weather was encountered which severely hampered the mooring operations. The current meter mooring could not be recovered and attempts to replace it were abandoned. It was also not possible to recover the sea bottom pressure gauge but it was successfully replaced. The CTD lines were successfully collected but the Loran-C receivers were unable to perform reliably on the Flemish Cap. The cruise terminated in St. John's, NL.

Next was a month-long geological cruise to the Scotian Shelf, Grand Banks and northwestern Newfoundland Shelf (Gordon Fader, BIO) (Cruise 80-010). The general purpose was to conduct geological and geophysical surveys using a multi-parameter integrated approach. Specific objectives included obtaining reconnaissance surficial and bedrock geology information, determining the extent and effects of Wisconsin glaciation on the Grand Banks, studying the nature and distribution of bedforms, determining the late glacial and post-glacial history of the shelf area, quantitatively mapping reflectivity and associated parameters, studying the distribution of iceberg furrows on the Grand Banks, especially in the Hibernia discovery area, and evaluating modifications to the Hunttec DTS. The following were collected: 4,200 km of airgun seismic reflection profiles, 150 km of Fairfield mini-sleeve seismic reflection profiles, 4,400 km of Hunttec DTS seismic profiles, 4,400 km of sidescan sonar profiles, 4,520 km of bathymetric profiles, 2,500 km of magnetic profiles, two piston cores, 25 bottom grabs and 13 bottom photograph stations. Four days were lost to bad weather. This was the first time that work was done at Hibernia where oil had just been discovered in 1979.

Next was a multidisciplinary cruise involving AOL, AGC and Dalhousie to the Sohm Abyssal Plain and Mid-Atlantic Ridge (Dave McKeown, BIO) (Cruise 80-016). Objectives included an extensive geological and geochemical study of the Sohm Abyssal Plain, calibration experiments with the Guildline digital CTD, acoustic positioning system trials, engineering trials and sample collection using the new deep water version of the BIO rock core drill, evaluating the *Hudson's* narrow beam sounder, oil tows and Doppler log calibration. The more specific objectives of the Sohm Abyssal Plain study included sampling bottom sediments using box, piston and gravity cores, sampling pore water, sampling the entire water column including the benthic boundary layer with a CTD Rosette, measuring sediment heat flow, photographing sediments and measuring current speed and direction just above the bottom. Bathymetric and seismic surveys were also carried out. All operations went well. Ten basalt and limestone cores were collected with the new rock core drill on the Mid-Atlantic Ridge. A port call was made in Bermuda to evacuate a sick crew member.

This was followed by a short cruise to Hamilton Bank on the Labrador Shelf (John Lazier, BIO) (Cruise 80-026). The purpose was to replace three current meter moorings on either side of the bank, occupy a grid of CTD stations and recover a deep sea tide gauge on Nain Bank. Observations of whale abundance and behaviour were also made. In addition, in preparation for the next cruise, a series radioactive tracer experiments using a temperature controlled incubator were conducted to investigate the relationship between light intensity and primary productivity of phytoplankton. Except for some noise problems with the CTD, all work went well. The cruise terminated in Saglek, NL.

Next was a major month-long biological cruise to the eastern arctic (Trevor Platt, BIO) (Cruise 80-027). This cruise marked BIO's first major biological expedition to high latitudes and initiated a multiyear arctic biological oceanographic program. Work was conducted in the Labrador Sea, Davis Strait, Baffin Bay, Melville Bay, Lancaster Sound, Jones Sound and Kane Basin. A large number of scientists and technicians from BIO and universities were involved. Rates of assimilation of ^{14}C by phytoplankton were measured

as a function of light intensity in artificial light incubators. Experiments were conducted to investigate nutrient assimilation and regeneration rates. Heterotrophic and autotrophic activities of microbial communities were studied. During the cruise, 156 CTD stations were occupied at a large number of locations. A series of experiments were run to examine the grazing and metabolic rates in zooplankton as well as experiments examining the digestive enzymes of zooplankton in relation to food supply. Studies of microzooplankton, zooplankton and micronekton were also conducted. Acoustic data were collected on all BIONESS tows to examine the vertical distribution of zooplankton. The modified Longhurst-Hardy Plankton Recorder (LHPR) functioned faultlessly. Batfish was used extensively to measure chlorophyll, zooplankton, salinity, temperature and depth. The new high volume pumping system was deployed and provided continuous vertical profiles of chlorophyll, temperature and depth as well as samples for particle analysis. Seabird observations were also made to examine the correlation between their abundance and that of plankton. Port calls were made at Pond Inlet and Resolute, NWT. During the cruise *Hudson* occupied a station at almost 80°N in the southern end of Nares Strait, probably further north than any previous oceanographic station occupied in the Canadian arctic. The cruise terminated in Thule, Greenland.

This was followed by a long geophysical, geological and chemical cruise to Baffin Bay and Davis Strait (Brian MacLean, BIO) (Cruise 80-028). The objectives of the first part were to conduct further studies of the oil seep at Scott Inlet by collecting samples from the surface microlayer, water column, unconsolidated sediments and bedrock and conducting geophysical profiling. In addition, water column and seabed sediments were collected in mid-Baffin Bay for analysis of nutrients, radionuclides, hydrocarbons, oxygen and salinity. Objectives of the second part included conducting reconnaissance investigations of the bedrock underlying the shelf between Clyde River and Cape Dyer by geophysical profiling and sampling, closing remaining regional bedrock information gaps on southern Baffin shelf area with emphasis on structures off Cumberland Sound and Cape Dyer, identifying rocks constituting the structure under Davis Strait, sampling unconsolidated sediments seaward from Frobisher Bay to obtain information on time of deposition and investigating sediments of Maktak Fjord. Except for bedrock sampling, the cruise objectives were achieved with a good degree of success. Weather conditions were excellent and ice was not a problem. Of particular note was the observation of numerous oil droplets erupting at the sea surface at the Scott Inlet oil seep. Port calls were made at Clyde River, NWT, Broughton Island, NWT and Holsteinsborg, Greenland to exchange personnel and the cruise terminated at Brevoort, NWT.

Next was a cruise to the Davis Strait and Labrador Shelf for hydrographic and geophysical surveys (H. Boudreau, BIO) (Cruise 80-035). The purpose was to conduct a broad multidisciplinary survey of northern Davis Strait at 32-km intervals gathering bathymetric, magnetic, gravity, seismic and sidescan data as well as information on surficial geology. Additional surveys were run on the Labrador Shelf out to a depth of 1,000 m. Data collected included 7,165 km of bathymetric profiles, 5,002 km of gravity and magnetic profiles, 3,954 km of seismic reflection profiles, 148 km of seismic refraction profiles, 970 km of sidescan sonar profiles and 1,400 km of Hunttec DTS

profiles. Overall the cruise was moderately successful and but not all objectives could be met due to the loss of the Loran-C Saglek slave station.

The last cruise of the year was a return visit to Hamilton Bank to continue the long-term current meter mooring program initiated in 1978 (John Lazier, BIO) (Cruise 80-037). The purpose was to recover and replace three current meter moorings and to occupy two lines of CTD stations across the bank in the vicinity of the moorings. Unfortunately, one of the moorings could not be recovered because the release failed to respond. In addition, on the return to BIO, a sidescan sonar line was obtained across the Strait of Belle Isle in the vicinity of the projected power cable from Labrador to Newfoundland. Overall the cruise was quite successful. The *Hudson* returned home in early November after three and a half months at sea in the eastern Arctic.



Available cruise stations/tracks for 1980

1981

As part of the Seabed II project being conducted in collaboration with Hunttec, the following modifications were made to *Hudson*

- The helicopter deck was shortened by cutting off the after 4-5 meters.
- The remaining helicopter deck was strengthened and a large Timberland deep tow winch was installed for towing the large Seabed II tow fish which contained a sidescan sonar and sub-bottom profiler which could be operated down to continental slope depths.
- The smaller A-frame was removed and, after below deck strengthening, a new crane was added to deploy and recover the tow fish. During towing, the crane was supported by a crutch.

Hudson was now equipped with two HP 2100 and one PDP 8E computers.

Cruises

Captain: Fred Mauger

Number of Cruises: 9

Days at Sea: 240

Nautical Miles Steamed (Reported): 34,034

This year *Hudson* undertook a nine-month expedition circumnavigating North America passing through the Panama Canal for the first time and the Northwest Passage for the second time. This cruise was broken down into nine legs which were assigned different cruise numbers.

The first leg was down the western North Atlantic and through the Caribbean Sea (Roger Pocklington, BIO) (Cruise 81-001). Various multidisciplinary studies were carried out along the way. The objectives of the geological program were to collect piston cores from abyssal sediments and bedrock cores from Plantagenet and Challenger banks southwest of Bermuda. The objectives of the chemistry program were to obtain a clearer picture of the concentrations of organic matter, nutrients and certain trace metals in the upper 2,000 m of the ocean to test the hypothesis that local accumulation of particulate and associated inorganic components occur at the interfaces between major water masses. The objectives of the biological program were to measure the effects of temperature on the light saturation parameters of natural phytoplankton assemblages and to measure the rate of adaption of phytoplankton from low to higher light regimes at the same temperature. With the exception of the rock core drilling, which had to be cancelled due to bad weather, all objectives were achieved. A brief stop was made in San Juan, Puerto Rico, and the leg ended in Colon, Panama.

After passing through the Panama Canal, *Hudson* made a port call in Balboa, Panama. The next leg was devoted to biological oceanographic studies in the Pacific immediately off the west coast of Central America (Trevor Platt, BIO) (Cruise 81-002). The purpose

was to carry out an experiment called BIOSTAT which involved detailed studies comparing the dynamics of two nearby planktonic ecosystems under stable environmental conditions. This experiment was designed around the proposition that a stable epipelagic ecosystem occurred in the eastern tropical Pacific Ocean where a permanent shallow thermocline exists and that this area should provide simplified conditions for the study of pelagic ecosystem processes. A variety of sampling gear was used to investigate physical properties, nutrients, phytoplankton, zooplankton and primary production. This included CTDs, bottle casts, a pump, Batfish, vertical plankton nets, BIONESS and the Longhurst-Hardy Plankton Recorder (LHPR). Partway through the cruise a port call was made in San Jose, Guatemala for a medical emergency. The leg terminated in Puntarenas, Costa Rica.

The next leg involved numerous multidisciplinary studies carried out by the Institute of Ocean Sciences (IOS) in Victoria, BC, BIO, the UBC Department of Oceanography and the Dalhousie Department of Geology (C.S. Wong, IOS) (Cruise 81-003). The objectives of the IOS program were to conduct a chemical oceanographic study off the continental west coast, study the marine carbon cycle with special reference to the supply and removal processes of carbon dioxide in upwelling areas, study the distribution of ultra-trace metals in water and surficial sediments and conduct a CTD survey in coastal waters with special reference to the California Undercurrent. The objectives of the BIO program were to measure various chemical variables in seawater and compare the results with data from the Atlantic, examine seabird distributions and collect tars balls in surface waters with a Neuston net. The UBC objectives were to investigate the sediment and interstitial water chemistry of sediments in contact with the oxygen minimum, study the geochemical factors affecting the formation of marine phosphorite deposits and study the geochemistry of barium and barite in hemipelagic sediments. And finally, the objective of the Dalhousie program was to investigate upper crustal structure of the East Pacific Rise using seismic refraction techniques. Partway through the cruise a short port call was made in Acapulco, Mexico to pick up parts for the Pengo winch. Somewhat later a second port call was made in San Diego, USA to exchange personnel and while there an open house was arranged for visitors from the Scripps Institution of Oceanography and the general public. After a brief refueling stop in Vancouver, this leg terminated at the Institute of Ocean Sciences (IOS) in Sidney, BC. The DFO Communications Branch in Ottawa sent a team to document activities between Puntarenas and San Diego.

The next three legs took place off the coast of British Columbia. The first was out to the Juan de Fuca Ridge and Explorer Seamount for geological and geophysical studies which included the drilling of basalt cores (R. Chase, UBC) (Cruise 81-017). Next was a leg in Hecate Strait and Queen Charlotte Sound for geological sampling and profiling (C. Yorath, IOS) (Cruise 81-021). This was followed by a geophysical survey of the Queen Charlotte fault zone (Roy Hyndman, IOS) (Cruise 81-022). The last leg terminated at the Institute of Ocean Sciences (IOS) in Sidney, BC.

After undergoing some engine repairs in Esquimalt, *Hudson* proceeded north around Alaska to the Beaufort Sea (T. O'Conner, IOS) (Cruise 81-027). On the way up the North Pacific, bathymetric data were collected for GEBCO and magnetic surveying was

carried out. When crossing the Arctic Circle, *Hudson* was visited by King Neptune. The main purpose of this leg was to conduct a hydrographic survey of the major shipping corridor through the Beaufort Sea. Oil and gas exploration and development activities were well underway and due to anticipated oil tanker traffic this area was the number one national priority of the Canadian Hydrographic Service (CHS) for surveying and charting. Of particular concern was mapping the distribution of pingo-like features which were known to arise abruptly from a featureless seabed to near the surface. ARGO shore stations for navigation were first set up using helicopters and then bathymetric surveys were run using five survey launches while *Hudson* conducted sidescan sonar surveys. During this period, port calls were made to Herschel Island, NWT to exchange personnel and Tuktoyaktuk, NWT for refueling. Despite poor weather and a shortened season, the program was successful and 52% of the corridor was surveyed.

When the work in the Beaufort Sea was finished, *Hudson* proceeded through the Northwest Passage. During Hudson 70 she had taken the northern route through the Prince of Wales Strait between Victoria and Banks islands to Viscount Melville Sound. However, this time she took the southern route south of Victoria Island, past Cambridge Bay to Queen Maud Gulf and then through Victoria Strait, Larsen Sound and Franklin Sound between Prince of Wales and Somerset Islands to Lancaster Sound. There were no problems with this passage.

After a port call in Resolute, NWT for personnel exchange, further hydrographic surveys were carried out in Lancaster Sound. This work also included setting up ARGO shore stations for navigation. During this phase a port call was made at Nanisivik, NWT on northern Baffin Island to pick up some geologists who then carried out seismic profiling and collected gravity cores in Lancaster Sound. At the completion of the program, *Hudson* returned to Resolute to exchange personnel.

The next leg featured various geological and geophysical studies in Lancaster Sound, Davis Strait, the Labrador Sea and on the Grand Banks (Mike Lewis, BIO) (Cruise 81-045). Objectives included collection of sediment samples, photographs and high resolution geophysical profiles in Lancaster Sound, measurement of bathymetry, seismic, magnetic and gravity properties of Davis Strait, measurement of iceberg scours and sediment bedforms across selected shelves, reconnaissance of sediments on the Labrador continental shelf, deployment of a current meter mooring in the Western Boundary Undercurrent and observations of seabirds. Partway through a port call was made to Godthaab, Greenland. Data collection included 6,007 km of bathymetry, 5,671 km of gravity profiles, 4,451 km of magnetic profiles, 2,605 km of seismic reflection profiling (single channel airgun), 1,041 km of high resolution seismic profiling (Huntec boomer) and 1,433 km of sidescan sonar. In addition, 86 grab samples, 39 gravity cores, six piston cores and one box core were collected and 650 seabed photos were taken. Storm-force winds and heavy seas at times hindered the program. This leg terminated in St. John's, NL.

The final leg before returning home to BIO was a physical oceanography cruise (Bob Reiniger, BIO) (Cruise 81-046). The objectives were to recover eight current meter

moorings in the Newfoundland Basin and to evaluate the new NAVSTAR global positioning system. This leg was a complete success. The weather was excellent and all equipment worked well so that all objectives were achieved. This was the first non-military use of the NAVSTAR navigation system which was configured to run in the standard shipboard BIONAV system. *Hudson* then returned home after an absence of eight months.



Available cruise stations/tracks for 1981

1982

By this time in its history, twenty years after its founding, BIO was fully integrated into the international family of oceanographic laboratories and was considered on par with the well-known Woods Hole Oceanographic Institution (WHOI) and the Scripps Institution of Oceanography (SIO). In August, BIO helped organize the 5th Joint Oceanographic Assembly which was held at Dalhousie University. This was attended by hundreds of leading oceanographers from around the world. One day an open house was held at BIO while *Hudson* was in port. During a dockside barbecue, Konstantin Federov, a leading oceanographer from the Soviet Union, sought out Alan Longhurst and pointing to the buildings and *Hudson* in turn he said "*That is the most elegantly organized oceanographic institute in the world and that is the most capable oceanographic ship in the western world*". Top marks indeed!

The concept of a mid-life refit for government research vessels was introduced at BIO about 1974. Previous to that, conventional wisdom said that when a ship was twenty years old it was time to consider replacement. However, experience with *Acadia* indicated that the basic ship, if adequately maintained during its working life, could be expected to last much longer even though changes might be needed in layout and equipment. Hence, the mid-life refit was introduced as a concept that would consider all aspects of the ship's construction and take appropriate steps to ensure that it would be reasonably operated for a further twenty-year period. The first step in any mid-life refit must be very detailed inspection of the hull. Assuming the hull is basically sound, the second step is to look at the ship's machinery. Some items may have worn out and others

may have become obsolete and need to be replaced. The third step is to examine accommodations and bring them up to the expected standards and safety regulations.

Accordingly, planning by the Manager of Institute Facilities began this year for a mid-life refit for *Hudson*, with input from ship's crew and the Ship Users Advisory Committee composed of BIO scientists. One of the many items under consideration was making improvements to the ventilation system to make *Hudson* more comfortable below decks while working in the tropics. Changes to the winch room, after deck A-frame and working area, helicopter deck and hanger were also discussed.

Cruises

Captain: Fred Mauger

Number of Cruises: 10

Days at Sea: 237

Nautical Miles Steamed (Reported): 35,412

The first cruise of the year was a two-month physical and chemical oceanography cruise to the Greenland and Norwegian seas (Allyn Clarke, BIO) (Cruise 82-001). The objectives were to obtain a high quality hydrographic data set during the late winter, study deep convection if occurring, obtain continuous measurements of the partial pressure of CO₂ and other gases in surface water and the atmospheric boundary layer, measure total carbonate and alkalinity throughout the water column and collect water samples for analysis of cesium, strontium, helium, tritium and freon. Data were also collected on the wintertime distribution of seabirds. The scientific party included a contingent from the Scripps Institution of Oceanography (SIO). This was the first time that *Hudson* was used to collect data to investigate the potential impacts of increasing concentrations of CO₂ in the atmosphere on ocean chemistry.

Soon after departing BIO, *Hudson* responded to a search and rescue call during a severe storm and steamed to the site of the *Ocean Ranger* on the Grand Banks. Unfortunately, the semi-submersible drilling platform had already capsized and sunk by the time she arrived on the scene. A day was spent performing recovery operations before diverting to St. John's to land recovered bodies. After this unfortunate incident, she resumed her program and headed for Reykjavik, Iceland. After a brief port call, CTD and Niskin bottle stations were occupied along numerous transects. Ice was encountered in many locations. The highest latitude reached was just over 79° N between Svalbard and Greenland. Partway through the cruise a port call was made in Tromso, Norway. The cruise was most successful. One hundred and twenty-nine deep hydrographic stations were occupied and 59 XBT profiles were obtained. The geographic coverage obtained was greater than planned because of better-than-expected weather conditions and the openness of ice. However, the deep convection study had to be cancelled because no evidence of this taking place was found. In addition, two current meter moorings were deployed for the University of Washington. The cruise terminated in Glasgow, UK.

This was followed by a cruise back across the North Atlantic for hydrography and ocean heat flux measurements along 48° N (Ross Hendry, BIO) (Cruise 82-002). The program included CTD and mooring work in the Gulf Stream. The heat flux measurements were done by a group from Dalhousie and Cambridge universities.

Next was a geological cruise to the Scotian Shelf and Slope (Keith Manchester, AGC) (Cruise 82-014). The scientific party included five geologists from the Lamont-Doherty Geological Observatory of Columbia University. The objectives included studying and mapping sedimentary slope processes with the new deep tow SEA MARC I sidescan sonar and seismic system, carrying out acceptance trials on a new KSS-30 sea gravimeter system, testing new heat flow measuring equipment, carrying out additional trials with the NAVSTAR navigation system and testing an airgun seismic system. The cruise was generally very successful and productive with a good mix of surveys and equipment testing.

This was followed by a cruise to the Nares Abyssal Plain south of Bermuda to study the history of deposition and geochemical reactivity of deep-sea sediments (Dale Buckley, BIO) (Cruise 82-018). Also on board were scientists from the Sandia National Laboratories, University of Rhode Island and the Lamont-Doherty Geological Observatory. The specific objectives were to conduct bathymetric and geophysical surveys over the Nares Abyssal Plain to determine the extent of flat-lying sediments and their thickness and acoustic stratigraphy. Core samples were obtained to determine the sedimentological, geochemical and stratigraphic nature of these sediments. These geological studies were combined with benthic biological studies which were intended to measure the vertical stratification of plant pigments, bacteria and megabenthic animals. Other studies measured the concentration of suspended sediments in the bottom nepheloid layer, the nature of benthic animal communities and the dynamics of water mass movement in the benthic boundary layer. Equipment used included seismics, CTD Rosette, various corers, heat flow probe, epibenthic sled, current meters, benthic camera and a baited camera mooring to capture live amphipods. All of these studies addressed questions concerning the distribution, nature and reactivity of deep ocean sediments, particularly as they relate to the properties for the safe disposal and containment of radioactive wastes under consideration by the international community. Preliminary results showed marked horizontal and vertical inhomogeneity suggesting that complex sedimentation and geochemical processes operated in this region. At the conclusion of work, *Hudson* streamed to Ponta Delgada on San Miguel Island, Azores. During this transit time, the scientific staff set up a display of equipment, techniques, samples and results for the ship's personnel.

Next was a multidisciplinary cruise between the Azores and Nova Scotia with a large contingent from Dalhousie (Pat Ryall, DAL) (Cruise 82-022). The main objective was to carry out a drilling program with a rock core drill on the western inner wall of the median valley of the Mid-Atlantic Ridge at 36° 25' N. While in that area, large volume water samples were collected for particulates, trace metals and biological studies. On the way back to BIO, additional water samples for particulate studies were collected over the abyssal plain plus several box cores and piston cores were collected on the continental rise and slope for paleontological studies. The cruise was quite successful. Seven cores

were recovered on the Ridge from depths ranging from 400 to 1,720 m. Trace metals measured included mercury and copper. Measurements were made of phytoplankton identification, abundance and primary productivity.

The next cruise was a late summer multidisciplinary expedition to the Labrador Shelf, Ungava Bay, Hudson Strait and Bay and the Foxe Basin (Peter Jones, BIO) (Cruise 82-027). The physical oceanographic program focused on studying the origin of the water found on the Labrador Shelf, in particular water from Hudson Bay discharged through Hudson Strait. This involved a detailed CTD survey of 130 stations. Current meter moorings deployed on the Labrador Shelf in October the previous year were recovered and redeployed while five new moorings were deployed in Hudson Strait. The prime purpose of the chemical program was to conduct surveys of key chemical variables, study their transport and examine various processes in which they are involved. These included nutrients and trace metals which can be useful for tracing water masses. Sources of freshwater were examined using oxygen isotope ratios and alkalinity. Background measures of hydrocarbons were also carried out. The biological program measured the geographic distribution of phytoplankton and zooplankton along the Labrador Shelf. Seabird observations were also made. The cruise terminated in Frobisher Bay, NWT.

Next was a geological cruise to study the sedimentology of fjords along the east coast of Baffin Island (Charlie Schafer, BIO) (Cruise 82-031). This was the first of three *Hudson* cruises as part of the Sedimentology of Arctic Fjords Experiment (SAFE) which involved three federal agencies and seven universities. It was designed to address climatology, hydrology, physical oceanography, sediment dynamics and animal-sediment relationships. The purpose of this initial cruise was to conduct a broad baseline survey of ten fjords: North Pangnirtung, Sunneshine, Coronation, Maktak, Tingin, Itirbilung, McBeth, Inugsuin, Clark and Cambridge. The sampling program included geophysical profiling, plankton tows, camera stations, piston coring and grab sampling. Water samples were occasionally collected. Nearshore data were collected using the ship's launches. Weather and ice conditions were most favourable throughout the cruise. The cruise terminated Pond Inlet, NWT.

This was followed by another geophysical and geological cruise to Baffin Bay and Davis Strait (Brian MacLean, BIO) (Cruise 82-034). The prime objective was to investigate the unconsolidated seabed sediments and underlying bedrock with a focus on the southeastern Baffin Shelf. Numerous magnetic and high-resolution seismic surveys were run including across Baffin Bay and Davis Strait. Samples of bedrock were obtained with an electric rock core drill with a 10 m penetration capability. These were the first bedrock samples ever collected in Hudson Strait and on the Baffin Island Shelf. Surficial sediment samples were collected with a large IKU grab. In addition, the current meter moorings deployed in Hudson Strait in August were recovered. Partway through the cruise a port call was made to exchange personnel in Godthaab, Greenland. The cruise terminated in Frobisher Bay, NWT.

Next was a geological cruise to the Labrador Shelf (Heiner Josenhans, BIO) (Cruise 82-054). The objective was to collect seismic reflection profiles and sediment samples

between Hudson Strait and Hamilton Bank in order to establish the thickness and nature of sediments above bedrock and to investigate the processes that affect these sediments with a particular interest in iceberg scouring. Another objective was to correlate the stratigraphic units identified offshore with those recently described and sampled onshore. The scientific party included staff from the University of Rhode Island, C Core, the Institute of Arctic and Alpine Research (INSTAAR), Dalhousie, Memorial, St. Andrews and Hunttec. Equipment used included the Hunttec DTS, airgun seismic reflection system, sidescan sonar, BRUTIV (Bottom Referencing Underwater Towed Instrumented Vehicle), sediment penetrometer, piston corer and the large IKU grab. This was the first time that BRUTIV, borrowed from St. Andrews, was used on *Hudson*. A total of 1,990 km of regional acoustic profiles was collected. Also nine piston cores, four IKU grabs and four BRUTIV tows were collected. Detailed bathymetric profiling and sample collection was made over several iceberg scours. Despite frequent bad weather, all objectives were met except geotechnical sampling of an iceberg scour. The cruise terminated in Cartwright, NL.

On the final cruise of this northern trip was another visit to the Labrador Sea for ongoing physical oceanographic studies (John Lazier, BIO) (Cruise 82-038). The purposes included continuing the long term monitoring program on Hamilton Bank by recovering previous current meter moorings and deploying new ones, mapping the northern branch of the North Atlantic Current, mapping the horizontal extent of temperature/salinity inversions associated with horizontal advection across the front and observing seabirds. Partway through a port call was made to St. John's, NL to pick up additional staff. The work on the North Atlantic Current involved Batfish tows, CTD stations, the launching of satellite-tracked drifters provided by the Institut für Meerekunde in Germany and deployment of four current meter moorings. The cruise was plagued throughout by bad weather which hampered operations. Several of the crew remarked it was the roughest cruise they had experienced. Nevertheless, due to *Hudson's* outstanding sea kindliness, most of the objectives were accomplished. When the program was completed, the ship returned to BIO after an absence of almost five months.



Available cruise stations/tracks for 1982

1983

Cruises

Captains: Fred Mauger/Loran Strum

Number of Cruises: 12

Days at Sea: 214

Nautical Miles Steamed (Estimated): 34,026

The first trip of the year was a biological cruise to the Sargasso Sea (Trevor Platt, BIO) (Cruise 83-002). The primary objective was to make a comprehensive series of biological oceanographic observations on the pelagic ecosystem at an oligotrophic station with the assistance of staff from Dalhousie and University of Toronto. The central question addressed was the degree of agreement between various methods of measuring pelagic production. A number of CTD stations were first occupied to find a suitable location with small horizontal gradients of temperature, salinity and oxygen in the upper 300 m for an intensive 10-day study. Observations of microstructure were measured with OCTOPROBE. Specific projects included investigating microbial processes, examining the uptake kinetics of phosphate by phytoplankton, measuring phytoplankton production using ^{14}C , conducting phytoplankton light saturation experiments, measuring abundance and production of picoplankton, measuring the productivity and respiration of microplankton using a highly precise Winker oxygen titration system and conducting experiments examining the grazing by microzooplankton on natural phytoplankton communities. In addition, a chemistry program collected large volumes of suspended particulate matter using Niskin bottles and a pumping system for inorganic and organic chemical analysis. Optical properties of water column were measured with a multi-wave transmissometer. The cruise ended in St. Georges, Bermuda.

This was followed by a geological and biological cruise to the Sargasso Sea in collaboration with Dalhousie (Pat Ryall, DAL) (Cruise 83-007). The purpose was to conduct further tests on the electric rock core drill, use the drill to collect samples of bedrock on side of the Bermuda Seamount down to a depth of 3,000 m, collect sediment samples with an undisturbed surface in deep water in the vicinity of Bermuda with a box corer, recover two biological moorings deployed off Bermuda in February and deploy and recover baited traps to capture scavenging amphipods just above the seafloor. The rock core drill was successfully tested and twelve bedrock cores were collected with the longest being almost 6 m in length. Ten suitable box cores were also collected. The major objectives for sampling abyssal scavenging amphipods were also met. The cruise terminated in St. George's, Bermuda.

On her way back to BIO, Hudson carried out a geophysical, physical and chemical oceanographic program in collaboration with Dalhousie, Memorial and Cambridge universities (Ross Hendry, BIO) (Cruise 83-009). The purpose was to place deep sea current meter moorings to begin a program to measure currents in the Gulf Stream, carry out a CTD survey over a region centred over the mooring array to obtain a synoptic description of temperature, salinity and dissolved oxygen distributions, test new heat flow

instruments and use them to measure heat flow through the earth's crust beneath the Sohm Abyssal Plain to test models of sea floor evolution, collect rain samples for pollution studies and test different navigation systems. Due to ideal weather conditions, the five moorings were deployed in just three working days. A total of 61 expendable bathythermographs (XBTs) were launched to plan the CTD survey. The CTD survey of 39 stations confirmed that the Gulf Stream was flowing through the moored array as planned. A total of 68 heat flow measurements were made at three separate sites and two piston cores were obtained for thermal conductivity measurements. Two rainwater samples were obtained under conditions that allowed good control over possible contamination from the ship's exhaust. The testing of navigation systems was successfully completed. Overall the cruise was most successful and terminated at BIO.

Next was a geological cruise to the Scotian Shelf, Laurentian Fan and Grand Banks with two legs conducted in collaboration with PetroCanada, Dalhousie, the Lamont-Doherty Geological Observatory and the University of Rhode Island (Keith Manchester/Bosko Loncarevic, BIO) (Cruise 83-017). The purpose was to test the new Timberland deep tow winch and Hampton crane for deep tow work, to carry out a SeaMARC I survey of the Laurentian Fan including testing of the new associated CHIRP sonar source, carry out KSS-30 sea gravimeter comparison testing, accuracy evaluation and provide field training in its use to PetroCanada staff, carry out sediment sampling in the Hibernia area using Vibracorer, carry out acoustic work for the Defence Research Establishment Atlantic (DREA) in conjunction with CFAV *Quest* on the Grand Banks using an acoustic sound source and small explosive charges, moor three current meter moorings for DFO St. John's in the Lilly Canyon, recover 13 ocean bottom seismometers (OBSs) and deploy nine new ones and test CTD performance. The OBSs were located at the mouth of the Laurentian Channel which is a region of micro-earthquake activity and site of the 1929 Grand Banks earthquake. The gear testing went well. A total of 863 km of SeaMARC data were collected to give about 4,000 km² sidescan sonar coverage which provided evidence of widespread slump scars, debris flows and other signs of sediment instability. The acoustic experiments with DREA went well and the two gravity meters compared well. The OBS operations went remarkably smoothly and the current meter moorings were deployed without incident. Vibracores ranging in length from 89 to 283 cm were recovered at 12 stations.

This was followed by a short geological cruise to the Scotian Shelf (Gordon Fader, BIO) (Cruise 83-019). The main purpose was to test the new Hunttec Seabed II integrated sediment mapping system (DTS) with numerous Hunttec staff on board. The large towed body now included sidescan sonar transducers and a prototype pressure compensated deep ocean boomer as a seismic source. This system represented a totally new generation of technology for seabed mapping. Surveys were conducted on Emerald Bank, Sable Island Bank and Sambro Bank. In addition, a prototype instrumented CTD block, a Datasonics transponder and an ORE Trackpoint system were tested. One day was lost to bad weather. Although it was not possible to test the system in deep water as planned, the work with the Seabed II system went well and provided Hunttec engineers with valuable experience in working at sea.

This was followed by another physical oceanographic cruise to the Labrador Sea (John Lazier, BIO) (Cruise 83-021). The purpose was to recover four current meter moorings deployed in the North Atlantic Current northeast of Flemish Cap in November 1982, run a series of CTD stations along the mooring line, continue the long-term current meter mooring program on Hamilton Bank by replacing the three moorings also deployed the previous November and occupy CTD stations on Hamilton Bank near the mooring sites. All moorings were recovered without difficulty. All releases responded to the enable command promptly and released on the first attempt. The CTD worked well but bottles on the rosette would not close properly in deep water. This cruise was noteworthy for it was the first time all current meters were recovered from over-wintering moorings on Hamilton Bank.

Next was a lengthy multidisciplinary cruise to the eastern arctic with a focus on biological oceanographic projects (Trevor Platt, BIO) (Cruise 83-023). This was similar to the cruise carried out in 1980. Work focused on Baffin Bay, Jones Sound, Kane Basin and Lancaster Sound. Biological projects addressed the activity of bacterioplankton at low temperatures, phytoplankton and picoplankton productivity, grazing of microzooplankton, zooplankton physiology, the vertical distribution of zooplankton and ichthyoplankton, measurement of plankton biomass size spectra, the biochemistry and physiology of arctic fish and the distribution of seabirds. Physical projects included carrying out a large number of CTD stations, tracking satellite buoys to study surface circulation, studying the optical properties of seawater and deploying four current meter moorings in northern Baffin Bay. Chemical projects included measurement of various biologically important compounds such as nutrients, oxygen and alkalinity as well as nutrient regeneration. The timing of the cruise coincided with the onset of the spring bloom and the intense biological activity assured that the various experiments worked well. Despite unusually heavy ice, the cruise was a great success and terminated in Thule, Greenland.

This was immediately followed by a geological cruise to three fjords on the east coast of Baffin Island (Jaia Syvitski/Charlie Schafer, BIO) (Cruise 83-028). Scientists from the Canadian Navy, Memorial, Queens, Alberta, Glasgow, Utrecht and the Institute of Arctic and Alpine Research (INSTAAR) participated. This was the second of three *Hudson* cruises to Baffin Island under the Sedimentology of Arctic Fjords Experiment (SAFE), a program which included participation by three federal government departments and several universities. SAFE was a comprehensive study on the climatology, hydrography, physical oceanography, sediment dynamics, sedimentological history and animal sediment relationships of Arctic fjords. The final product of this program was to be a workable model capable of predicting the fate of natural sediment with inference to waste disposal, a problem of increasing significance with northern development. Work focused on three fjords representing different conditions: Cambridge Fjord, Itirbilung Fjord and McBeth Fjord. All three had been sampled the previous year. In all three fjords, *Hudson* did routine seismics as well as light sampling during the night while heavier deck work such as piston coring was left for daylight hours. Station work consisted of bottom grabs, vertical plankton tows, underwater photography, Lehigh coring, piston coring and CTD profiling. During the day while *Hudson* was doing routine station work, two launches

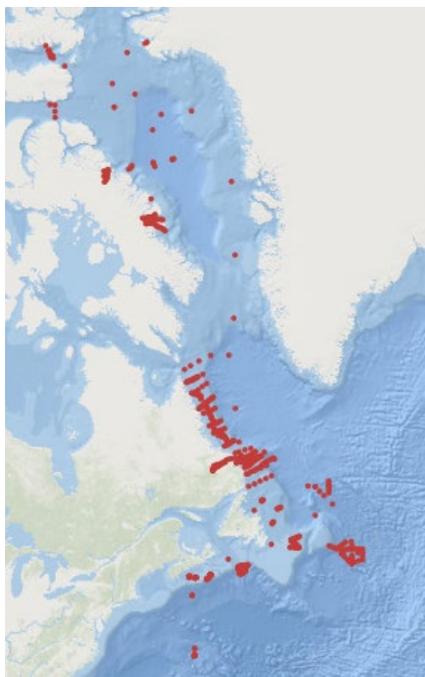
and two Boston whalers conducted independent surveys including bathymetry, acoustic profiling, sidescan sonar and grab sampling. Three weeks prior to this cruise, a helicopter program was conducted which included setting up Aanderaa weather stations, sediment trap moorings as well as an array of Aanderaa current meters and thermistor chains. This equipment was retrieved at the end of the cruise. The cruise ended in Frobisher Bay, NWT.

Next was a geological and chemical cruise to the Labrador Shelf and Lake Melville (Gus Vilks, BIO) (Cruise 83-030). Sediment at 97 stations was sampled using the IKU bucket grab, van Veen grab, piston corer and Lehigh corer. Seismic and sidescan sonar data were collected along seven lines. Seabed photos were also taken. Samples of water and sediment were collected at 97 stations for chemical analysis along with CTD profiles. These analyses focused on petroleum-related substances and oxygen. Unlike the Baffin Island area, no evidence of natural hydrocarbon seepage was observed. A current meter mooring was deployed in Lake Melville. Despite some bad weather, 75% of the objectives were successfully completed. The cruise terminated in Lewisporte, NL.

This cruise was immediately followed by a geological cruise to the Labrador Shelf and Grand Banks (Gus Vilks, BIO) (Cruise 83-033). Also participating were staff from the Resource and Geochemistry Division in Ottawa, St. Andrews Biological Station (SABS), Dalhousie, C-Core, Hunttec and the French CBC. The cruise was designed to investigate the Quaternary history of the northeastern Grand Banks with special emphasis on paleoecology, stratigraphy and mechanisms responsible for sediment instability. Twenty-two piston cores and IKU grab samples were collected and 650 km of seafloor was surveyed with the improved Hunttec DTS and airgun. Sediment stability was investigated in the Hibernia area with the BRUTIV camera sled, airgun (523 km), Hunttec DTS (600 km), sidescan sonar (513 km) and IKU grab samples. An iceberg grounding site near Hibernia previously documented by Mobil was revisited and surveyed in detail. The cruise terminated in St. John's, NL.

Next was another physical oceanography cruise to Hamilton Bank (John Lazier, BIO) (Cruise 83-036). The program included replacement of current meter moorings, CTD surveys, Batfish sections and a survey of the Polar Front. The cruise terminated at St. John's, NL.

This was followed by a short geological cruise to Baie d'Espoir, Fortune Bay and Hermitage Channel on the south coast of Newfoundland led by Memorial University (Alex Hay, MUN) (Cruise 83-043). Two current meter moorings were deployed, 57 CTD stations were occupied and heat flow measurements were made at 15 stations. When work was completed, *Hudson* returned to BIO after an absence of 138 days and ready for a well-deserved holiday.



Available cruise stations for 1983

1984

The Gulf of Maine boundary dispute with US was resolved by the International Court of Justice in Den Hague. The decision awarded the resource-rich northeast peak of Georges Bank to Canada and opened up the potential for oil and gas exploration.

A gas blowout occurred at the Venture field on Sable Island Bank which took eight months to cap. Oil was discovered at the Terra Nova and White Rose sites on the Grand Banks.

Cruises

Captains: Fred Mauger/Ross Dickenson

Number of Cruises: 14

Days at Sea: 215

Nautical Miles Steamed (Reported): 30,978

The first cruise of the year was to the Gulf of St. Lawrence in late January and early February (Gary Bugden, BIO) (Cruise 84-001). The diverse purposes of this winter cruise included repeating CTD profiles, using a rosette sampler to collect oxygen and nutrient data over the standard grid of ice forecasting stations, recovering previously deployed satellite thermistor buoys, measuring particulate organic carbon, nitrogen and total organic carbon at key sections to calculate the mass balance of organic carbon in the Gulf, collecting samples of suspended particulate matter, phytoplankton and bacteria, performing a detailed CTD survey of the north shore region to evaluate the impact of

proposed hydroelectric power developments, collecting ice cores for nutrient, alkalinity and salinity analysis and deploying a sediment trap and collecting box cores in the St. Lawrence Estuary. Many of these measurements were the first of their kind to be attempted during the winter months and provided a first look at seasonal variations in the physical, chemical and biological processes at work in the Gulf. The cruise was a general success with all primary objectives accomplished. Very few problems were encountered operating in the ice.

In April, *Hudson* made a cruise to the Grand Banks to conduct numerous plankton and benthic surveys in order to collect information that could be used to help construct and validate a numerical model of the Grand Banks ecosystem being developed to help evaluate the effects of a possible oil spill at Hibernia (Trevor Platt, BIO) (Cruise 84-010).

This was followed by a physical oceanographic cruise to the Gulf Stream (Ross Hendry, BIO) (Cruise 84-012). The five current meter moorings deployed in 1983 were recovered and five replacement moorings with a total of 20 Aanderaa current meters were deployed to continue the Gulf Stream Statistical and Mapping Experiment for a final year. In addition, two engineering test moorings using long sections of Kevlar rope were deployed and recovered and a hydrographic survey involving 50 CTD stations and 78 XBT deployments was carried out in the vicinity of the moored array. Heat flow measurements planned by Dalhousie had to be cancelled at the last moment because of problems with the Pengo winch.

Next was a geophysical cruise to determine the deep structure of the continental margin south the Grand Banks (Charlotte Keen, BIO) (Cruise 84-021). This margin is one of the best examples of a transform margin, as opposed to a rifted margin, in the Atlantic Region. This objective was achieved by obtaining 3,000 km of bathymetric data and 2,200 km seismic reflection data, delineating the sedimentary stratigraphy of the basement, and by three seismic refraction experiments using ocean bottom seismometers (OBSs) which defined the deeper crustal structure down to the crust-mantle boundary. Immediately after leaving BIO, *Hudson* proceeded to the Bedford Magazine to load explosives for the seismic refraction work. Now that the Pengo winch had been repaired, a second cruise objective was for Dalhousie to obtain heat flow measurements on the nearby Sohm Abyssal Plain. In addition, bathymetric data were collected in an area of numerous unmapped seamounts. The cruise was very successful in all respects despite the constraints under which it had to operate regarding explosives. The cruise terminated in St. John's, NL. This was the last time that explosives were used on *Hudson* for seismic work.

This was followed by a short geophysical and geological cruise to the Avalon Channel (Mike Lewis, BIO) (Cruise 84-024). Three geophysical transects were run across previous low sea level positions and evidence was found of relic and recent iceberg scours. Evidence of previous low sea level was found only in deep, wave-protected basins. Comparative sound velocity profiles were obtained over Cretaceous-Tertiary, Cambro-Devonian and Precambrian rocks in seismic refraction experiments. Useful information was also obtained using the towed BRUTIV video sled. Data collected

included 229 km of Hunttec DTS, 386 km of sidescan sonar, 187 km of seismic reflection, 24 km of seismic refraction and 39 km of BRUTIV tows. In addition, 10 piston cores and 18 grab samples were collected. The cruise was most successful and upon completion of the program *Hudson* proceeded to St. John's, NL.

This was followed by a physical oceanographic cruise to Hamilton Bank (John Lazier, BIO) (Cruise 84-026). The purpose was to continue the long-term monitoring program by recovering three current meter moorings deployed in 1983 and replacing them, mapping the temperature, salinity, oxygen and velocity distributions over and near Hamilton Bank with CTD stations, Batfish tows and velocity profiles obtained with the acoustic water velocity profiling system and measuring phytoplankton primary productivity at the CTD stations. The cruise took place about six weeks after the winter ice disappeared. The mooring work was carried out without incident. Thirty-six CTD stations were occupied along three lines across the Labrador Shelf, 53 hours of Batfish tows were made in the Labrador Current and primary productivity was measured at 28 stations. High levels of biological productivity were observed. After successfully completing the program, *Hudson* returned to BIO.

Next was a geological cruise to the Scotian Shelf and Slope in collaboration with Hunttec (Gordon Fader, BIO) (Cruise 84-029). The main purpose was testing the new Hunttec Seabed II deep-tow seabed geological mapping system (DTS) in order to determine its acceptance by the Crown as a deliverable of an interdepartmental government-funded project. This system consisted of a two-stage towed body with depressor and sensor packages. The sensor package contained sidescan sonar transducers and a prototype pressure-compensated deep ocean boomer as a seismic source. This was the second sea trial of the system and results exceeded expectations. It proved very reliable and was launched and retrieved five times. In Verrill Canyon, the Hunttec Seabed II system (DTS) was successfully towed at depths down to 2,000 m and produced the first high-resolution seismic profiles with over 200 m sub-bottom penetration. Its sidescan sonar sensors covered 2.5 km on either side of the towfish. A second objective of the cruise was to obtain shallow water sidescan sonograms across areas of Sable Island Bank thought to have shell beds and collect seabed samples with an epibenthic sled, grabs and photographs as part of a sediment stability study. Good weather occurred during the entire cruise.

This was followed by a geological and geophysical cruise to the Labrador Sea with participants from Memorial, McGill, Quebec and Dalhousie universities (Shiri Srivastava, BIO) (Cruise 84-030). The objectives were to carry out geological and geophysical surveys of three sites in the Labrador Sea, collect continuous geological and geophysical data between the sites for correlation purposes, collect sediment cores at each site for sedimentological, paleo-environment and sediment dynamics studies, make heat flow measurements at each site and carry out a reconnaissance survey across the North Atlantic Mid Ocean Channel (NAMOC) in the central Labrador Sea. A lot of time at the start of the cruise was devoted to getting the various pieces of seismic equipment working but once they were operational excellent data were collected. Gravity, magnetic and bathymetric data were also collected. Navigation was based on the BIONAV system.

Twenty-four sediment cores were collected and 52 heat flow measurements made. Despite bad weather for most of the cruise, overall it was quite successful and most of the goals were accomplished. The cruise ended in St. John's, NL.

Next was another geological cruise in the same general area which was broken into two legs (Cruise 84-035). The first leg examined the seabed features in the Flemish Pass and on the continental shelf and slope offshore of Labrador in collaboration with the Lamont-Doherty Geological Observatory using their Sea Marc (Sea Floor Mapping and Remote Characterization) I system (Charlie Schafer, BIO). Sea Marc I was a deep-towed acoustic swath mapping system capable of obtaining slant-range-corrected sidescan images in a swath up to 5 km wide. Shallow seismic reflection profiles and bathymetric data were also collected. Objectives included investigating the sediment transport features below the axis of the Western Boundary Undercurrent, surveying submarine slide features and iceberg scours in the vicinity of several offshore petroleum exploration sites and conducting a geophysical and geological study of the northern flank of the Sackville Spur. The Sea Marc I system proved to be an exciting new tool for studying the morphology of the ocean floor. This first leg terminated in Makkovik, NL.

The second leg examined the seabed features of the continental shelf and slope offshore of Labrador and southeast Baffin Island, again in collaboration with the Lamont-Doherty Geological Observatory using their Sea Marc I system (Brian McLean, BIO). Shallow seismic reflection profiles and bathymetric data were also collected. The primary objectives were to investigate sediment features associated with the Western Boundary Undercurrent on the continental slope off Labrador, examine ridge features (morainal or giant ice scours) on the shelf off Hudson Strait, carry out a brief Hunttec DTS transect and core stratified sediments northeast of Resolution Island, survey exploratory well locations to examine variations in iceberg scour characteristics and topography, investigate seabed features on the north side of Saglek Bank and investigate glacial and bedrock features in the Cartwright Saddle area. With the exception of the Hunttec DTS, all equipment functioned satisfactorily. However, the cruise program was hampered by a steady succession of low pressure systems with gale force winds which tracked through the survey area during the last nine days of the cruise so that all objectives could not be obtained. This second leg terminated in Goose Bay, NL.

Next was a physical oceanography cruise off Labrador which involved participation from the Institute of Ocean Sciences (IOS) in Sidney, BC to gain experience in mooring technology (John Lazier, BIO) (Cruise 84-038). The purpose was to continue the long-term mooring program on Hamilton Bank and obtain temperature and salinity measurements near the current meter moorings and on a line across the continental shelf and slope. Three current meter moorings were recovered and replaced and 25 CTD stations were occupied. In addition, a current meter mooring was recovered and two sediment cores obtained in Lake Melville. Weather was good and all objectives were obtained. The cruise ended in St. John's, NL.

Next was a geological cruise in October to the Laurentian Fan which involved collaboration with Dalhousie and the Lamont-Doherty Geological Observatory (David

Piper, BIO) (Cruise 84-040). The objectives were to collect Sea Marc I sidescan sonar data from the Eastern Valley and lobe-levee contact area of the Laurentian Fan in order to evaluate sediment deposition processes, obtain air or water gun seismic profiles on the Laurentian Fan to improve existing stratigraphic knowledge and develop the chirp sonar system mounted on Sea Marc I. These objectives were only partially met because of bad weather and several equipment failures. In addition, three sediment cores were collected from the Laurentian Fan. After completing the program, *Hudson* returned to BIO after an absence of three months.

Hudson then headed south for the rest of the year. The first cruise employed the rock core drill and a towed TV camera in the Sargasso Sea (Pat Ryall, DAL) (Cruise 84-045). It terminated in St. George's, Bermuda.

Next was a multidisciplinary cruise to the southern Bermuda Rise and southern Nares Abyssal Plain (Dale Buckley BIO) (Cruise 84-046) which included participants from the University of Rhode Island, Lamont-Doherty Geological Observatory and NORDCO. The main objectives of the cruise were devoted to the study of deep-sea sediments and benthic ecology in a small area of the southern Nares Abyssal Plain. The cruise plan included a seabed survey with Sea Marc I to obtain detailed information of sediment surface morphology and acoustic stratigraphy over an area where numerous faults had previously been identified. A new large diameter piston corer was used to collect samples for geochemical, stratigraphic and geotechnical analysis. Most of these objectives were related to questions concerning the feasibility of using deep-sea sediments for the safe containment of disposed radioactive wastes. Seismic and bathymetric data were collected. Biological work aimed to quantify the biomass of benthic organisms of different size classes collected by box corer and epibenthic sled and measure their activity. A number of moorings were deployed to hold experimental equipment at fixed height above the seabed. This equipment included Aanderaa current meters, time-lapse cameras and baited traps to attract deep-sea amphipods. Despite the unfortunate loss of Sea Marc I and the biological mooring experiment, objectives were mostly met. Highlights included exceptional high quality bathymetric and seismic survey data, successful biological experiments which provided new information on deep sea benthic communities, unique biogeochemical experiments of water-sediment exchanges and pore water properties, successful testing of a new global positioning system (GPS) which could position the ship to less than 50 m, testing a new piston coring system and collecting sediment cores of record length. This cruise terminated in Bridgetown, Barbados.

The final cruise of the year investigated plankton biology and larval squid dynamics in the Caribbean Sea and along the US continental shelf on the way back to BIO (Trevor Platt, BIO) (Cruise 84-049).



Available cruise stations/tracks for 1984

1985

Cruises

Captains: Fred Mauger/Ross Dickinson

Number of Cruises: 11

Days at Sea: 216

Nautical Miles Steamed (Reported): 28,836

First was a geological cruise in late March to the Scotian Slope and Laurentian Fan (David Piper, BIO) (Cruise 85-001). Participants from Dalhousie, Technical University of Nova Scotia and Memorial were also involved. The purpose was to investigate seabed stability in the vicinity of the recently drilled Albatross and Shubenacadie exploration wells using corers and seismic profilers, study the gravel waves in the eastern valley of the Laurentian fan and the evolution of the valley through the Pleistocene and obtain cores for Pleistocene stratigraphy on the Laurentian Fan and Fogo Seamounts. Seismic reflection data were obtained using the Huntec DTS and airgun systems. Other sampling equipment used included sidescan sonar, piston corers, box corers, gravity corers and seabed cameras. The cruise was most successful and ended in St. John's, NL.

This was followed by a geological cruise to the Grand Banks which was broken into two legs with a brief stopover in St. John's (Gordon Fader, BIO) (Cruise 85-005). The purpose of the first leg was to carry out a regional geological-geophysical survey of the southeastern Grand Banks in order to study the surficial and shallow bedrock geology of the area. It represented the first collection of regional high-resolution, seismic reflection

and sidescan sonograms from this area and complemented data collected by *Hudson* to the north and east in 1980. The broad objectives were to collect bedrock data for the preparation of geological maps in support of studies of geological history, determine the extent of recent glaciation, study the distribution, characteristics and genesis of bedforms, map the reflectivity of seabed sediments, study the distribution and characteristic of relict and modern iceberg furrows, study the post-glacial transgression history and assess the aggregate potential of sediments from a resource point of view. These data later contributed to the preparation of environmental impact statements related to hydrocarbon production and pipeline routes. This program was continued on the second leg along with testing of the NORDCO rock core drill in the Avalon Channel. In addition, the Loran-C navigation was evaluated and a crew from the National Film Board (NFB) did some filming. Despite losing four days to bad weather, the cruise was very successful with all objectives met.

Next was a month-long cruise the Mid-Atlantic Ridge (Larry Mayer, DAL) (Cruise 85-010). This included participants from the Woods Hole Oceanographic Institution (WHOI), Texas A&M University, University of Rhode Island and Lamont-Doherty Geological Observatory. The two major programs were to conduct a survey to select targets suitable for bare rock drilling for the upcoming Ocean Drilling Program (ODP) Leg 106 at the Kane Fracture Zone and to use the Dalhousie/BIO rock core drill in the same area. In addition, a small coring program was conducted while in transit to the Ridge to collect sediment samples for paleoceanographic analysis. The ODP, continuation of the highly successful Deep Sea Drilling Program (DSDP), began in January 1985 and employed the *Joides Resolution* as the drill ship. Bathymetric and magnetic data were continuously recorded while underway. The Sea MARC I and the Lamont camera system were used to locate potential drilling sites. Three such sites were successfully located. Five holes were successfully drilled with the rock core drill. For the most part the cruise was problem free and extremely successful. It terminated in Ponta Delgada in the Azores.

This was followed by a physical and biological cruise to the Canary Basin which was a joint endeavour with Dalhousie University (Neil Oakey, BIO) (Cruise 85-014). The purpose was to study a deep eddy of warm saline water known as MEDDY which had been discovered in 1984 and originated from outflow from the Mediterranean Sea. If MEDDYs were common and long-lasting events, they could be significant in the heat and salt budgets of the North Atlantic. Once the eddy was located, an intensive CTD survey was carried out and the rate of energy dissipation was examined using EPSONDE to measure microstructure and turbulence. This was the first time that this tethered-free-fall profiler, developed at BIO, was used and it was extensively modified during the cruise. The EPSONDE system was generally successful and provided good data of both temperature and velocity microstructure to depths greater than 1,500 m. The biological program investigated for the first time the rate of turbulent nitrate flux from deep water into the euphotic zone. The cruise terminated in St. John's, NL.

Next was a combined physical and biological cruise to the southern Labrador Shelf (John Lazier, BIO) (Cruise 85-018). As part of the program started in 1978, three current meter

moorings were recovered and replaced on Hamilton Bank. Four pressure gauge moorings were deployed across the shelf in order to improve calculations of water transport. Thirty-six CTD stations were occupied on four lines across the shelf in the neighbourhood of the current meters. Primary productivity by phytoplankton was measured at selected sites and intermittent Batfish tows were made across the Labrador Current. Turbulence was measured with EPSONDE at five positions across the core of the Labrador Current. Zooplankton samples were collected for grazing experiments and seabird and mammal observations were carried out during daylight hours. At the completion of the program, *Hudson* returned to BIO after an absence of almost three months.

This was followed by a physical and biological cruise to Browns Bank, Georges Bank and the Sargasso Sea which included participation by Dalhousie University (Glen Harrison, BIO) (Cruise 85-020). A current meter array was deployed in the tidal front region in the Canadian sector of Georges Bank, a series of CTD transects and anchor stations were carried out in both the Canadian and US sectors of Georges Bank, two transect lines were run across Browns Bank for a Canada Centre for Remote Sensing (CCRS) aircraft remote-sensing experiment and various biological and optical studies were carried out.

Next was a geophysical cruise to the area immediately south of the Flemish Cap (I. Reid, BIO) (Cruise 85-025). The basic objective was to study the deep crustal structure across the transition zone between continental and oceanic crust by running closely-spaced seismic refraction lines using an airgun source and OBS receivers. The southern margin of Flemish Cap was chosen for the study because of its apparent structural simplicity, the absence of thick obscuring sediment and the availability of some previous seismic reflection data for planning purposes. Navigation was based on BIONAV using LORAN and satellite. Data collected included 2,100 km of bathymetry, 800 km of digital seismic reflection and 400 km of seismic refraction. Unexpected problems with the OBSs occurred so less refraction data were obtained than planned. However, the data obtained were of good quality. The cruise terminated in St. John's, NL.

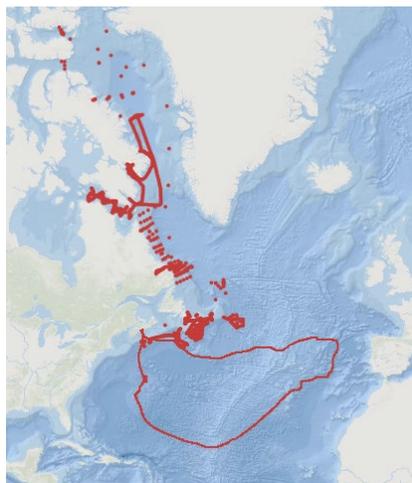
This was followed by a biological cruise in late summer to Ungava Bay and the Labrador Shelf which involved participation from the Champlain Centre for Marine Science, the Northwest Atlantic Fisheries Centre (NAFC), Memorial and McGill universities (Ken Drinkwater, BIO) (Cruise 85-031). The first objective was to measure particle spectra over a wide size range along the Labrador Shelf from Hamilton Bank north to Cape Chidley. Earlier studies had suggested that mixing in Hudson Strait and Ungava Bay produced nutrient-rich surface waters which were subsequently advected onto the Labrador Shelf where they could stimulate primary production. If so, this could drive a developing food chain as the water moves southward with the residual current. Particle size range measurements included bacteria, phytoplankton, zooplankton and fish. The fish data were collected using the ECOLOG acoustic system developed at BIO. In addition, benthic samples were collected at selected sites for particle size measurements and seabird counts were made as well. Temperature, salinity, current, nutrient and chlorophyll data were also collected. The second objective was to examine the

distribution of zooplankton and fish larvae across a tidal front in Ungava Bay. Temperature, salinity, water structure, nutrient, phytoplankton, benthic and adult fish data were also collected. A CTD survey of Ungava Bay had to be cancelled due to lack of time. However, additional studies included geological coring in Nachvak Fjord, zooplankton sampling for experiments examining the relationship between copepod feeding behaviour and chlorophyll distribution and ichthyoplankton sampling to document the distribution of capelin larvae on the Labrador Shelf. Partway through a brief port call was made at Nachvak Fjord, NL to exchange personnel. The cruise ended in Frobisher Bay, NWT.

Next was a geological cruise to Davis Strait, Baffin Bay and Hudson Strait (Brian MacLean, BIO) (Cruise 85-027). The program included surficial sediment sampling for paleoecological studies and surficial sediment shallow bedrock mapping and sampling using high-resolution seismic techniques and the shallow water electric NORDCO rock core drill. Partway through the cruise a brief visit was made to Pangnirtung, NWT to exchange staff. The cruise terminated in Goose Bay, NL. It was recommended that better quality movies be selected for evening entertainment.

This was followed by another cruise to the Labrador Sea for more geophysical studies (Keith Loudon, DAL) (Cruise 85-034). The program included heat flow measurements and seismic profiling. The cruise ended in St. John's, NL.

The final cruise of the year was to the Flemish Pass which involved collaboration with NORDCO and Huntec (Keith Manchester, BIO) (Cruise 85-044). The primary purpose was to sample bedrock using the NORDCO rock core drill. In addition, piston cores were collected to aid in the interpretation of SeaMARC sidescan data collected from this region in 1984 and both Huntec DTS (287 km) and airgun seismic reflection data (185 km) were collected. Navigation was provided by BIONAV using Loran and satellite inputs. Some time was lost to bad weather but most objectives were met. The cruise terminated at BIO after an absence of three months in northern waters and the crew was ready for a well-deserved holiday and winter alongside.



Available cruise stations/tracks for 1985

1986

This year marked the start of major changes in the management of the Department of Fisheries and Oceans (DFO) which had a profound impact on BIO. The position of Regional Director General of Ocean Science and Surveys was abolished and replaced with the position of Regional Science Director. Alan Longhurst returned to the bench as a research scientist and Barry Muir became the new Regional Science Director. This new position continued to include the responsibility for managing the BIO fleet of research vessels. Barry was a fisheries biologist-turned manager with no appreciable sea-going experience. This new position now reported to a Regional Director-General which marked the end of direct reporting to Ottawa for BIO oceanography programs, including the management of the BIO fleet of research vessels.

The Panuke field was discovered on Sable Island Bank which would later form part of the Cohasset-Panuke Project (Copan).

Cruises

Captains: Fred Mauger/John Lewis

Number of Cruises: 9

Days at Sea: 186

Nautical Miles Steamed (Reported): 27,489

The first cruise of the year was to have been to the Scotian Shelf for sediment transport studies in the Sable Island Bank area but unfortunately it had to be cancelled at the very last moment due to engine issues (Carl Amos, BIO). The participants driving down from Quebec in a blizzard were not very happy.

Once the necessary repairs were made, *Hudson* departed on a physical and chemical oceanographic cruise with two legs to the Newfoundland Basin (Allyn Clarke, BIO) (Cruise 86-006). This was the first of three planned cruises to study the circulation pattern and water mass distributions within this area southeast of the Grand Banks. The objectives were to set current meter arrays upstream and downstream of the Newfoundland seamounts, occupy an array of full depth CTD stations over the western and central Newfoundland Basin with special emphasis on the lower continental slope, collect and analyze water samples for nutrients, oxygen, alkalinity/total carbonate and freons, map the upper ocean structures between the Labrador Current and the North Atlantic Current using Batfish and the Ametek-Straza Acoustic Doppler Current (ADCP) profiler and run tests on a new Kevlar CTD cable. Nine current meter moorings were successfully deployed and 65 CTD stations were occupied. After some initial problems, Batfish performed well. It was concluded that the new Kevlar CTD cable might be suitable for shallow water work but not deep water. Partway through the cruise a port call was made into St. John's, NL, to exchange of personnel and equipment. The program near the end of the cruise had to be reduced due to fuel allocation restrictions (6.5 tons per day) imposed at the last minute. The cruise terminated at BIO.

This was followed by a geophysical cruise to the Orphan Basin and continental margin east of the Grand Banks (I. Reid, BIO) (Cruise 86-013). The purpose was to investigate the deep crustal structure beneath the Orphan Basin and adjacent continental margin using seismic refraction techniques. A new airgun array was used to provide a powerful well-controlled seismic source and 23 ocean bottom seismometers (OBSs) were deployed to improve efficiency and data quality. Enroute to the study area, six piston cores were collected on the slope of the southwestern Grand Banks. Unfortunately, lots of bad weather was encountered and five OBSs could not be recovered. Continuing fuel allocation limits, as imposed on the previous cruise, placed additional constraints on the program. Nevertheless, approximately 4,800 km of seismic profiling was successfully carried out and excellent data were collected. The cruise terminated in St. John's, NL.

Next was a geological cruise to the Grand Banks which involved students from Memorial, Dalhousie, Queens and the University of Maine (Gordon Fader, BIO) (Cruise 86-017). The broad objectives were to study the surficial and shallow bedrock geology of the area, a topic of particular interest to the developing offshore oil and gas industry. Specific objectives included collecting surficial sediment and bedrock data in support of geological history studies, determining the extent of glaciations, studying sediment mobility, studying the isostatic and eustatic history of the area, mapping seabed reflectivity, studying the distribution of relic and modern iceberg furrows, understanding the Holocene transgression of the area, assessing aggregate potential and evaluating the CIGAL system for routine acquisition and logging of navigation and geophysical data. Primary sampling tools included sidescan sonar, the Hunttec DTS, the airgun seismic reflection system, piston cores, the Vibracorer, IKU grab, van Veen grab and seabed camera. No time was lost to bad weather and cruise objectives were met with a high degree of success. The cruise terminated in St. John's, NL.

This was followed by another geological cruise to the Grand Banks and Flemish Pass which was a joint venture with Centre for Cold Ocean Resources Engineering (C-CORE) at Memorial University (Russ Parrott, BIO) (Cruise 86-018). Departing from St. John's, investigations included studies of iceberg scour incidence and degradation, the stability of surficial sediments, the geotechnical and acoustic properties of sediments, the Tertiary stratigraphy of the northeastern Grand Banks of Newfoundland, diapiric structures and Quaternary stratigraphy. In addition, a deep-towed seismic reflection seismic system for determining velocities from Hunttec DTS data was tested and the RALPH seabed monitoring system was deployed at a site where tracer material had previously been placed. Seismic, sidescan sonar, BRUTIV camera sled and sediment data were collected to document the distribution and properties of the Tertiary stratigraphy and surficial sediments. A Remotely Operated Vehicle (ROV) was also used for detailed studies of selected features. Sampling locations included the Hibernia area. The cruise ended at BIO.

Next was a physical oceanographic cruise for further studies of the Labrador Current (John Lazier, BIO) (Cruise 86-021). This was the fourteenth in a series of cruises, initiated in October 1978, to measure important variables in the Labrador Current. It was

divided into two legs. The objectives of the first leg were to recover three current meter moorings and four pressure gauge moorings placed in the vicinity of Hamilton Bank in July and August 1985 and to deploy eleven new moorings. Another purpose was to obtain Batfish and CTD data in lines across the shelf and slope through the front associated with the main branch of the Labrador Current. In the process, water samples were collected for determination of salinity, dissolved oxygen, nutrients, freon and tritium. In addition, sea bird and marine mammal distributions were made during daylight hours. The first leg terminated in Cartwright, NL.

The second leg carried out work further north on Nain Bank, in the Labrador Sea and in Baffin Bay (Charlie Ross, BIO). The purpose was to recover moorings deployed in 1985, deploy new moorings on Nain Bank and the eastern side of Baffin Bay, determine temperature/salinity distributions in the area of the moorings using CTDs and Batfish, collect large volumes of seawater in the West Greenland Current for radionuclide analysis and determine freon profiles in eastern and northern Baffin Bay. Equipment worked well and all objectives were achieved. Ice was encountered in Lancaster Sound and Barrow Strait on the way to Resolute, NWT where the cruise terminated.

Next was a month-long multidisciplinary cruise to the Arctic islands (Brian MacLean, BIO) which started in Resolute (Cruise 86-027). The ambitious program in relatively unknown waters involved the collection of geological, geophysical, geotechnical, physical, biological and hydrographic data. The areas sampled included Lancaster Sound, Barrow Strait, Viscount Melville Channel, Wellington Channel, Queens Channel, Austin Channel, Byam Channel and Hudson Strait. The geological work investigated both sediments and bedrock, including nearshore areas. Equipment used included a seismic reflection system, Huntec DTS, sidescan sonar and various grabs and corers. Seabed thermal data were also collected. Biological studies investigated ambient phytoplankton concentrations and the relationships between metabolic and feeding rates of zooplankton. In addition, the possible enhancement of benthic biomass in regions of polynyas was investigated. Equipment used for this work included a CTD, bottle casts, plankton nets and bottom grabs. Bathymetric data were also collected along all cruise tracks. A helicopter was used to transfer personal ashore for coastal geological studies. Although ice conditions were generally worse than normal, the cruise was successful in obtaining extensive information. However, fuel limitations were still a major concern. The cruise terminated in Deception Bay, NWT.

This was followed by a physical oceanographic cruise to Hudson Strait and Ungava Bay for further studies on the effects of Hudson Bay outflow on the Labrador Shelf (Ken Drinkwater, BIO) (Cruise 86-029). The main objectives were to investigate the role of tidal mixing and local freshwater runoff on the physical characteristics of the water in Ungava Bay and to measure the seasonality of the outflow in Hudson Strait which carries low salinity water originating from Hudson Bay and Foxe Basin. An extensive CTD survey was carried out in Ungava Bay which included the collection of water samples for the analysis of nutrients and chlorophyll. The observed vertical stratification was compared with predictions from a numerical tidal model to identify regions of tidal

mixing. A current meter mooring and tide gauge array were deployed along the south coast in central Hudson Strait for one year to test the hypothesis that the strength of the outflowing current is related to freshwater fluxes from ice melt and Hudson Bay runoff. All objectives were met and the cruise terminated at Cape Dorset, NWT on Baffin Island.

Next was a geological cruise to Hudson Bay and the Labrador Shelf which was divided into two legs (Heiner Josenhans/Charlie Schafer, BIO) (Cruise 86-040). The first leg collected seismic reflection data to map the regional stratigraphy of Hudson Bay. The weather was exceptionally good and 90% of the objectives were met. At the end of this program, *Hudson* returned to Deception Bay to disembark seismic personal. The second leg investigated the paleoceanography and sedimentation processes on the Labrador Shelf and involved an airgun seismic survey, piston coring and box coring. Due in part to the continuing fuel restrictions, not all objectives could be fulfilled. The cruise terminated in St. John's, NL.

This was followed by another geological cruise to the Newfoundland and Scotian slopes (David Piper, BIO) (Cruise 86-034). The objectives were to obtain geotechnical and biostratigraphic core samples and seismic reflection profiles in order to evaluate sediment stability. Equipment used included the Huntec DTS and an airgun seismic system as well as various corers. Approximately 600 km of seismic data and 41 cores were collected. Specific work areas included St. Pierre Slope, Laurentian Fan, Logan Canyon and Emerald Basin. The program was somewhat restricted by the imposed fuel restrictions which did not account for weather conditions. At the end of the program, *Hudson* returned to BIO after an absence of almost four months.



Available cruise stations/tracks for 1986

1987

This year marked the 25th anniversary of BIO. It was also a year of huge changes in the organization of DFO Science which impacted all users of *Hudson*. The Marine Ecology Laboratory (MEL) was disbanded and most staff were assigned to the new Biological Science Branch (BSB). The Atlantic Oceanographic Laboratory (AOL) became the Physical and Chemical Sciences Branch (PCSB). Both these new branches as well as the Canadian Hydrographic Service (CHS) now reported to the recently created Regional Director of Science position which was now filled by Steve MacPhee, a former hydrographer with seagoing experience. In addition, the operation of the BIO fleet of research vessels including *Hudson* was transferred to the new Management Services Branch. These organizational changes were accompanied with significant resource cuts. Nevertheless, high priority research programs continued and *Hudson* remained a critical source of ship time.

Cruises

Captain: Loran Strum

Number of Cruises: 10

Days at Sea: 190

Nautical Miles Steamed (Reported): 30,613

The first cruise of the year was to the Scotian Shelf, Scotian Slope and Laurentian Fan for geophysical studies and testing new equipment (Keith Manchester, BIO) (Cruise 87-003). The scientific party included staff from Dalhousie, Memorial, University of Rhode Island, University of Paris, the Woods Hole Oceanographic Institution (WHOI), the French Institute for Ocean Science (IFREMER) and Seakem, Ltd. The specific objectives included seismic, magnetic and gravity surveys, testing the new long core facility and various coring and dredging activities. The operation of the long core facility on its first use went exceedingly well. Due to poor weather at the end of the cruise, the magnetic and gravity surveys at the Montagnais meteor impact site on LaHave Bank had to be cancelled.

Next was a geological and chemical cruise to the Grand Banks, Fogo Seamounts and Laurentian Fan which involved participation by Memorial, French Institute for Ocean Science (IFREMER), the University of Rhode Island, Brookhaven and John's Hopkins University (David Piper, BIO) (Cruise 87-008). The general objectives were to carry out studies of the stratigraphy and geotechnical properties of the continental margin and studies of carbon fluxes to deep-water sediments. Eleven cores were successfully collected with the new long core facility. Huntec DTS data were successfully obtained at water depths up to 5,000 m on the Laurentian Fan. Two sediment trap moorings were successfully deployed and recovered. Amphipod traps on the moorings provided information of the distribution and feeding rates of abyssal crustaceans. In addition, three box corers were successfully collected in abyssal sediments. During this cruise, the program was interrupted so that *Hudson* could respond to a search and rescue call. All 24 crew members of the MV *Skipper I*, a large bulk-carrier registered in Panama which had

founded and sunk off the Grand Banks in hurricane-force winds, were rescued and taken into St. John's, NL. The cruise ended in St. John's, NL.

The following cruise returned to the Grand Banks for further geological studies with the participation of Seastar, Lobsiger Associates and George Washington University (Gordon Fader, BIO) (Cruise 87-014). These were part of the continuing program to map the surficial sediments and shallow bedrock geology of the Grand Banks and to understand the processes affecting the sediments. Specific objectives included investigating a gas seep in Downing Basin, mapping a channel system on the northern Grand Banks, studying the distribution of sediments, boulders and bedforms in the Hibernia area in cooperation with Mobil Oil Canada Ltd. for assessment of the Hibernia development plan, investigate a large area of peculiar bedforms south of Hibernia, survey and sample seashell beds on Southeast Shoal, study an area of sand ridges on southern Grand Banks and assess the mineralogy aggregate potential of the area. Equipment used included sidescan sonar, Huntec DTS, an airgun seismic reflection system, various grabs, dredges and corers and the underwater towed camera sled BRUTIV equipped with still and video cameras and sidescan sonar. Due to good weather, all objectives were met. Upon completion of the program, *Hudson* returned to St. John's, NL.

The next cruise returned to the Grand Banks for further geophysical studies (Charlotte Keen, BIO) (Cruise 87-019). Staff from Seakem were also involved. This was part of continuing studies of the sedimentary basins and continental margins around the Grand Banks. The primary purpose was to conduct four seismic refraction experiments using ocean bottom seismometers (OBSs) and an array of six airguns as the sound source to complement earlier seismic reflection studies. These experiments were conducted across the Jeanne d'Arc Basin, across the southern Grand Banks, across the margin east of the Grand Banks and northeast of Flemish Cap. In addition, gravity and magnetic surveys were run wherever possible. Except for the last few days, the weather was good. With the exception of a failed amphipod trap experiment, all goals were achieved. The cruise terminated at BIO.

This was followed by a month-long biological cruise to the open North Atlantic (Trevor Platt, BIO) (Cruise 87-022). The basic purpose was to investigate features in the distribution of phytoplankton biomass which were visible in basin-wide satellite imagery collected by NASA. This imagery showed the existence of discrete patches of unusually high pigment concentrations on the order of 50 km in extent. The goal was to investigate the origin and lifetime of these patches in order to obtain a better understanding of global primary production. In addition, the results were expected to bear on the climate change issue since areas of locally-enhanced primary production could be expected to draw down more CO₂ from the atmosphere. The overall sampling program was designed to test the hypothesis that biological production over seamounts is enhanced due to modification of oceanographic conditions by bottom topography. This hypothesis was tested in the area of the New England and Corner Seamounts on the Sohm Abyssal Plain. Physical oceanographic measurements were made using CTD, EPSONDE, XBTs, Batfish and an Ametek-Straza Acoustic Doppler Current Profiler (ADCP) system. Vertical profiles of light were also collected. Primary production in surface water was measured in ten

in-situ experiments. Samples for inorganic nutrients, POC, PON and species identification were also collected. BIONESS was used to collect zooplankton. Additional related work included determining phytoplankton metabolism, picoplankton studies, zooplankton feeding and excretion and bacterial activity and growth. This was the first time that biological work on *Hudson* focused on the climate change issue, a concept which was now well accepted in the international oceanographic community.

Next was a geophysical cruise to the Labrador Sea organized in collaboration with McGill (Keith Loudon, DAL) (Cruise 87-025). The purpose was to investigate ocean crust spreading rates in the Northwest Atlantic Mid-Ocean Channel (NAMOC) and the nature of recent sediment deposition. Sampling included bathymetry, seismic reflection surveys, seismic refraction surveys using OBSs, heat flow measurements and coring. The cruise was a complete success and terminated at Cape Dorset, NWT.

Next was a geological cruise to Hudson Bay which included participants from the St. Andrews Biological Station (SABS), McGill, the University of Quebec, Hunttec and NORDCO (Heiner Josenhans, BIO) (Cruise 87-028). The objectives were to obtain seismic and sample data of the bedrock and surficial sediments in order to determine the vertical and lateral distribution of surficial and subsurface geological units. Equipment used included Hunttec DTS, airgun seismic system with two hydrophones, sidescan sonar, piston cores, various grabs, CTD, bottom cameras, BRUTIV, BIO/NORDCO rock core drill and sediment velocity meter. Bottom photographs and high-resolution sidescan data were collected to determine sediment dynamics. A nearshore survey at the entrance to Great Whale River was carried out to determine the contemporary and paleo sediment/water output dynamics at the river mouth. The cruise terminated in Churchill, MB.

This was followed by a geophysical and physical oceanographic cruise in Hudson Bay, Hudson Strait, Davis Strait and the Labrador Sea (Charlie Ross, BIO) (Cruise 87-031). The objectives were to conduct seismic profiling in Hudson Bay, conduct a CTD survey and recover five current meter moorings in Hudson Strait, carry out CTD surveys in Davis Strait and Baffin Sea, deploy five current meter moorings in Davis Strait and recover four current meter moorings in Baffin Bay. During the cruise, personnel transfers were made at Cape Dorset, NWT and Koartac, PQ. The cruise was most successful and all objectives were attained. It terminated at Clyde River, NWT.

Hudson then stayed north for further geological studies in Davis Strait, Baffin Bay, Hudson Strait and the Labrador Sea (Gus Vilks, BIO) (Cruise 87-033). This cruise included participants from Hunttec, the University of Quebec, Dalhousie, Memorial and the University of Rhode Island. The objectives were to establish the sedimentary history of the Baffin Island continental shelf and slope and to relate the results to the Ocean Drilling Program (ODP) Site 645 survey and drilling program. In addition, it was intended to extend the regional Quaternary stratigraphy to deeper horizons using the long coring facility. Equipment used included the Hunttec DTS, airgun and various corers and grabs. The cruise was most successful and ended in St. John's, NL.

The final cruise of the year was to the Newfoundland Basin for further physical oceanographic studies (Allyn Clarke, BIO) (Cruise 87-037). This was the final of three cruises designed to study circulation patterns and water mass distributions within this area southeast of the Grand Banks. Specific objectives included recovering two lines of current meter moorings set in May 1986, carrying out a CTD survey of the region, determining the concentrations of oxygen, nutrients, alkalinity, freons and various halocarbons to identify and eventual model the water mass distributions and fluxes, using Batfish to map surface water in frontal systems and testing CTD, Batfish and navigation software on the new MICROVAX computer system. At the end of the program, *Hudson* returned to BIO after an absence of five months.



Available cruise stations/tracks for 1987

1988

A twelve-year drilling moratorium for the Canadian sector of Georges Bank was announced by the federal and provincial governments.

David Deer, captain from 1974 to 1978, passed away.

Cruises

Captain: Loran Strum/Fred Mauger

Number of Cruises: 8

Days at Sea: 130

Nautical Miles Steamed (Reported): 17,588

The first cruise of the year was a short one for physical oceanography which was run in collaboration with Brooke Ocean Technology (Allyn Clarke, BIO) (Cruise 88-000). A modified Batfish system was tested in ice-covered water while in transit from St. John's to BIO.

The next cruise was to the North Atlantic off the Grand Banks for further physical oceanographic studies (Ross Hendry, BIO) (88-001). This cruise marked the beginning of field work for the Intergyre Exchange Experiment which was investigating the circulation and distribution of water properties over the southeast Newfoundland Ridge. In addition, a complementary program investigating the geochemistry of trace metals was carried out. Specific objectives included deploying seven current meter moorings, carrying out a CTD Rosette water sampling program, investigating the distribution of manganese and other dissolved trace metals, carrying out a Batfish/Acoustic Doppler Current Profiler (ADCP) survey, collecting samples of suspended particulate matter for analysis of adsorbed radionuclides, carrying out engineering trials of a new submersible pump system and deploying two current meter moorings and one surface pressure buoy on the Southeast Shoal. Unfortunately, due a last minute delay in departure because of ship problems, the major CTD Rosette sampling program over the southeast Newfoundland Ridge had to be cancelled.

Several days were lost to search and rescue work when *Hudson* was requested to steam to the assistance of the *Athenian Venture*, a Greek oil tanker carrying gasoline which exploded and broke into two about 690 km south of Cape Race, NL while enroute from Amsterdam to New York. At the time of the explosion, *Hudson* was about three hours away but the fire was visible in the night sky as the ship approached the burning wreckage. A daylong search found only one charred body of the twenty-nine people believed to be on board. There were no survivors. At the end of the cruise *Hudson* returned to BIO.

This was followed by a biological cruise to the Labrador Shelf, the Strait of Belle Isle and Scotian Shelf (Trevor Platt, BIO) (Cruise 88-014). It was organized under the Canada-Germany bilateral agreement and included participants from GKSS Forschungszentrum, University of Oldenburg, Institut für Allgemein Botanik, Institut für Meereskunde, the University of Tokyo as well as Dalhousie. The main purpose was to collect optical and biological information that would aid in the interpretation of remotely-sensed data on ocean colour and solar-stimulated fluorescence. To this end, a variety of optical instruments, including several prototypes, were deployed in an area of high phytoplankton biomass on the Labrador Shelf. In addition, work included measurements of the concentrations and rates of assimilation of nitrate and ammonium to generate estimates of new and regenerated primary production. Water sampling was done using a CTD Rosette equipped with a fluorometer, light sensor and Niskin bottles as well as the flow-through system using the ship's seawater supply. The cruise was most successful despite the high incidence of foggy days.

This was followed by a geological cruise to the Scotian Shelf and Slope (David Piper, BIO) (Cruise 88-010). The objectives were to continue investigation of sediment instability on the Scotian Slope, continue studies of the chronology and style of glaciation on the Scotian Shelf, investigate the geotechnical and acoustic properties of glacial sediments and the development of diagenetic minerals in Emerald Basin, obtain seismic and core data in the area of a previous survey to better constrain interpretations of modern and Pleistocene sedimentation and obtain dredge samples of Tertiary strata from the walls of the Gully. Major activities were seismic reflection profiling, piston coring, box coring and dredging. Geochemical analyses were carried out on sediment samples to determine the redox state and extent of diagenesis. The cruise was a technical success and met most of the primary objectives. However, it was hampered by bad weather during the last week and three injuries to deck crew, one of which required evacuation by helicopter.

Next was another geophysical cruise to the Scotian Shelf which was run jointly with the Geological Survey of Canada in Ottawa (Bosko Loncarevic, BIO) (Cruise 88-020). The objective was to investigate a deep basement structure underlying the Montagnais well site on southern La Have Bank by conducting a geophysical survey. This structure was a suspected meteor crater on the order of 45 km in diameter created approximately 50 million years ago. Bathymetric, gravity and magnetic surveys were carried out using BIONAV for navigation. Seismic reflection surveys were also conducted using an array of six airguns mounted on a rigid frame. It was concluded that the data collected were consistent with the hypothesis that the Montagnais structure was caused by a cosmic body impact. While over 100 impact craters on land were known, this was the first one discovered anywhere in the world ocean.

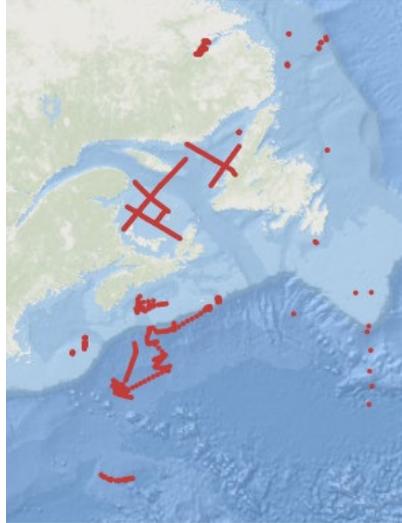
This was followed by a geophysical cruise to the Gulf of St. Lawrence which included participants from Dalhousie and Seakem (I. Reid, BIO) (Cruise 88-022). The purpose was to collect seismic refraction data using OBSs as well as single-channel seismic reflection data of the deep crustal structure in the Gulf of St. Lawrence. Equipment and procedures were identical to those of previous *Hudson* cruises to the area in 1986 and 1987. Surveys were carried out in the southern part of the Magdalen Basin, across the Appalachian structural front and between Quebec and Newfoundland. In addition, a new digital data acquisition system recently developed by AGC was tested which offered many advantages over the current analog system. Partway through a visit was made to Corner Brook, NL to pick up spare parts and exchange personnel for medical reasons. The cruise was extremely successful for two reasons. First the weather conditions were excellent. Secondly, this was the third year in a row for conducting such intensive OBS refraction surveys so all initial problems had been ironed out and personnel were well experienced. The cruise terminated in Corner Brook, NL.

The following cruise was to the Labrador Shelf for further geophysical studies organized in collaboration with McGill (Keith Loudon, DAL) (Cruise 88-024). The purposes were to conduct a seismic refraction survey using OBSs along and across the west Greenland margin to study crustal structure, conduct heat flow measurements in the Labrador Sea to measure present geothermal heat flux and conduct high resolution seismic reflection

profiles along with sediment piston coring to study the nature of recent sedimentation patterns in the North Atlantic Mid Ocean Channel (NAMOC) and along the Labrador margin. A total of 222 km of seismic refraction profiles and 453 km of seismic reflection profiles were carried out. In addition, 13 piston cores were collected and 26 heat flow stations occupied. The cruise was most successful and returned to BIO.

Next was a biological cruise which was divided into two legs and included participants from Dalhousie, Plymouth, University of Montreal and University of Chicago (Glen Harrison, BIO) (Cruise 88-026). The first leg worked in the northeast sector of Georges Bank while the second worked in the western Sargasso Sea. The objectives of the first leg were to continue and expand work begun in 1985 on the role of tidal fronts on the exchange of water masses on other properties on and off the Bank and on the high biological production occurring there. Four CTD transects were run and six 36-48 hour anchor stations were conducted for physical and biological measurements. The objectives of the second leg, called NFLUX, were to experimentally test a hypothesis concerning the role of vertically-migrating zooplankton in the export of dissolved nitrogen (principally ammonia) downwards from the surface to the deep ocean. Operations to this end were carried out over a nine-day period at a drift station southeast of the Gulf Stream. Additional work included studies of new and regenerated primary production, zooplankton physiology, vertical distribution of zooplankton, picoplankton, microbes, sea scallops, benthic organic seston, stable carbon and nitrogen isotopes and seabirds. No major problems were encountered and all objectives were met.

In late September, *Hudson* sailed to St. John's, NL for a lengthy major mid-life refit. Several major improvements were made. A larger coring Pengo winch was installed on the foredeck replacing the earlier coring winch. This winch had two drums: a large drum with 5,000 m of $\frac{3}{4}$ inch cable and a second smaller drum with $\frac{1}{2}$ inch cable. The controls to the forward starboard hydraulic crane and coring winch were installed inside a weather-protected winch room on the forward starboard side of the foredeck. In addition, the chief scientist's cabin was moved forward to the port side using space which was previously part of the Forward Lab. The freed space was used to relocate the main entrance to the ship interior and install an additional female cabin. New enclosed lifeboats were also installed to replace the original open ones. These and other improvements were expected to enable the *Hudson* to provide continued valuable sea-going support to the Atlantic Canada marine scientific community for many years to come.



Available cruise stations/tracks for 1988

1989

In October when the mid-life refit was completed, *Hudson* returned from St. John's to BIO after an absence of over one year.

Cruises

Captain: Loran Strum

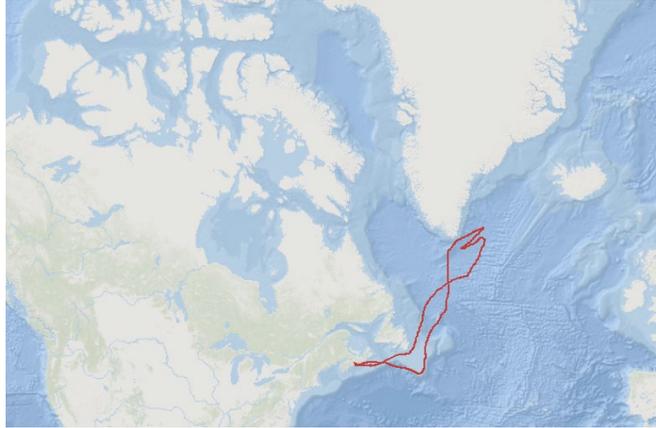
Number of Cruises: 2

Days at Sea: 27

Nautical Miles Steamed (Estimated): 4,374

In November, a geological cruise was made to the Newfoundland Slope and Basin in collaboration with Memorial (Peta Mudie, BIO) (Cruise 89-030). The purpose was to obtain bathymetric data, conduct sidescan sonar surveys to map slump structures, conduct high-resolution seismic surveys and collect piston and box cores for paleoceanographic studies. The cruise terminated in St. John's, NL.

This was followed by a geophysical cruise to the Labrador Sea (Claude Hillaire-Marcel, UQAM) (Cruise 89-033). The objectives were to obtain seismic reflection profiles from the continental margin off southwest Greenland, collect geochemical and biostratigraphic cores and water samples in order to reconstruct paleoceanographic changes during the last 130,000 years and collect seismic reflection profiles and sedimentological core samples from the North Atlantic Mid Ocean Channel (NAMOC). Equipment used included airgun systems, long piston corer, box corer and Niskin bottles. The cruise terminated at BIO.



Available cruise tracks for 1989

1990

Cruises

Captain: Loran Strum

Number of Cruises: 12

Days at Sea: 259

Nautical Miles Steamed (Reported): 30,008

In early January, *Hudson* proceeded to the Newfoundland Basin south of the Grand Banks for further physical oceanographic studies (Ross Hendry, BIO) (Cruise 89-037). This was the second cruise for the Intergyre Exchange Experiment begun in 1988 which was investigating the circulation and distribution of water properties over the southeast Newfoundland Ridge. The overall purpose of the program was to gain a quantitative understanding of the role of ocean currents in transporting heat from southern latitudes to the northern North Atlantic. Specific objectives included recovering seven deep moorings with 25 Aanderaa current meters, carrying out a CTD Rosette water sampling survey of the Gulf Stream, North Atlantic Current and Labrador Current near the Tail of the Banks and carrying out a Batfish and ADCP survey of the Labrador Current near the southern boundary of the Grand Banks. Analyses of water samples included oxygen, dissolved silicate, phosphate, nitrate and nitrite. Except for the loss of one mooring during recovery, all objectives were successfully completed. However, during the cruise approximately ten hours were lost when an exceptionally large wave broke over the foredeck and washed away the bow motor air vent which required immediate repairs. This cruise, which terminated back at BIO, was a contribution to the recently established international World Ocean Circulation Experiment (WOCE).

The following cruise was to the Bermuda Rise and Baltimore Canyon organized in collaboration with Dalhousie University (Kate Moran, BIO) (Cruise 89-038). The Bermuda Rise is one of the best sites in the North Atlantic to investigate high-resolution paleoclimatology the relatively high rate of sedimentation that occurs there. Basic physical data and *in-situ* pore pressure measurements were made in piston core samples

in order to understand the mechanisms of sediment stress history. The Baltimore Canyon was the area was chosen because the Ocean Drilling Program (ODP) had selected it as a site to drill a margin-wide stratigraphic transect. In addition, the distribution of benthic foraminifera was examined for paleoceanographic studies. Equipment used included the Hunttec DTS and airgun for high-resolution seismic reflection, long piston cores and box cores.

The next cruise was in March to Georges Bank for sediment transport studies (Carl Amos, BIO) (Cruise 89-039). Also involved were scientists from Dalhousie, Acadia, the French Institute for Ocean Science (IFREMER), University of Wales, University of Aberdeen, University of Southampton, University of Alberta, Old Dominion University and the British Admiralty. There were numerous purposes which included running seismic and sidescan surveys to map surface sediment distribution on Georges Bank, mapping the distribution of bedforms, determining the long-term sediment transport pathways, sources of sediment and sites of accretion, collecting bottom sediment samples for grain size determination and to evaluate grain size spatial trends along sediment transport pathways, collecting box cores and vibracores from each of the bedform zones to evaluate changes in sediment facies along sediment transport pathways, monitoring sediment transport under storm conditions at four sites of varying grain size, current and wave conditions, evaluating the concept of the “hydraulic fence” on the bank edges of Georges Bank and determining the resuspended carbon and nitrogen fluxes and the quantity and quality of seston available to sea scallops on Georges Bank. Equipment used included sidescan sonar, an airgun seismic system, Seistech seismic system, Vibracorer, box corer, IKU grab, van Veen grab, RALPH and BOSS (Benthic Organic Seston Sampler). The cruise was most successful and a valuable database on Georges Bank sediments was collected.

Next was a cruise to the Northwest Atlantic for biological studies which included participants from Dalhousie, University of Waterloo, University of Hamburg, University of Sao Paulo and the Smithsonian Environmental Institute (Trevor Platt, BIO) (Cruise 90-001). This cruise was a continuation of the program initiated on *Baffin* Cruise 89-003 in April/May 1989 as part of the North Atlantic Pilot Study of the newly-established Joint Global Ocean Flux Study (JGOFS). Specifically, the cruise was intended to further understanding of the dynamics of the spring phytoplankton bloom in the open waters of the North Atlantic, a brief period of intense biological activity which accounts for a substantial fraction of the year’s total primary production. To this end, a deep-water station was occupied for ten days. Equipment used included a CTD Rosette with sampling bottles, a biological pump, light meter, BIONESS and Batfish. In addition to primary production, measurements were also made of the distribution and density of zooplankton, physical and chemical properties of seawater, particulate matter and microbial communities. In addition, two sediment trap arrays were deployed to examine vertical fluxes of carbon and successfully recovered. Extremely high rates of primary production were observed and major reductions in the concentrations of inorganic nutrients were observed. These results challenged the view that the open ocean is a permanently oligotrophic ecosystem with low primary production. Unfortunately, the

scientific program was cut short because of a medical emergency which necessitated an unscheduled steam to St. John's, NL.

Next was a geological cruise to the Grand Banks, Orphan Knoll, Milne Seamount, Newfoundland Basin and Newfoundland Slope which was organized in collaboration with Memorial University (Peta Mudie, BIO) (Cruise 90-007). The scientific objectives were to collect continuous bathymetric data at depths greater than 200 m around the Grand Banks and northern Newfoundland Basin, conduct detailed shallow seismic surveys of Newfoundland Seamount and Milne seamounts, collect long cores and box cores for paleoceanographic records of Newfoundland Basin and NW Atlantic pollution studies, conduct high resolution seismic and sidescan sonar surveys of the southern Newfoundland Slope to map slump structures and, if time permitted, get seismic profiles and cores from Orphan Knoll for paleoceanographic and pollution records. Equipment used included an airgun system, the Hunttec DTS seismic system, long piston corer and box corer. Before starting the scientific program, *Hudson* steamed to St. John's to install the Hunttec DTS. The cruise was most successful and ended in St. John's, NL.

This was followed by a geophysical cruise to the Labrador Sea and Newfoundland coast which included participants from McGill University (Claude Hillaire-Marcel, UQAM) (Cruise 90-013). The scientific objectives were to obtain seismic reflection profiles from the continental margins of southwestern Greenland and northeastern Labrador, collect sedimentological, geochemical and biostratigraphic cores from both areas and collect seismic profiles and cores from the northeast Newfoundland coastal area including Notre Dame Bay, Baie Verte, White Bay and Green Bay. Sampling equipment included the Hunttec DTS, an airgun system, sidescan sonar, magnetometer plus various grabs and corers. Partway through the cruise, *Hudson* steamed to Lewisporte, NL for a personnel exchange. The cruise was most successful and terminated at BIO.

Next was a geological cruise to the St. Pierre Slope and Verrill Canyon on the Scotian Slope which was run in collaboration with French colleagues from the French Institute for Ocean Science (IFREMER) (David Piper, BIO) (Cruise 90-015). The general purpose was to define small-scale instability features on the continental slope and to relate these to the physical properties of the sediment. The French high-precision, deep-tow digital sidescan system SeaMARC and the Hunttec DTS were used to image the seafloor. Numerous cores were also collected. About 400 km of high-resolution sidescan data were obtained on the St. Pierre Slope and the head of the Eastern Valley around the epicentre of the 1929 earthquake which created a turbidity current that ruptured a series of communication cables on the seabed. Abundant methane was found in sediment cores. Geotechnical measurements were made in sediments at various locations to provide an assessment of sediment stability at different levels in the stratigraphic column. More than 350 km of sidescan sonar imagery were obtained in the area between Verrill Canyon and the Shelburne well and the seaward zonation of physiographic regions was found to be similar to that observed on the St. Pierre Slope. *Hudson* returned to BIO a few days early due to adverse weather.

This was followed by a geophysical cruise to the Labrador Sea (I. Reid, BIO) (Cruise 90-019). The purpose was to conduct further studies of the deep oceanic crust using seismic tools and heat flow measurements. It terminated at Lewisporte, NL.

Next was a physical oceanography cruise to Davis Strait and Baffin Bay in collaboration with Dalhousie University (Charlie Ross, BIO) (Cruise 90-022). The purpose was to complete the three-year program of measuring the transport of water through Davis Strait, measure the level of naturally-occurring volatile halocarbons in arctic seawater and measure the level of bromoform in interstitial waters. Six current meter moorings were successfully recovered and the equipment returned in excellent condition. CTD Rosette stations were occupied for analysis of oxygen, nutrients and volatile halocarbons. Sediment was collected by box corer for pore water analysis. The cruise was most successful and ended at Iqualuit, NWT.

This was followed by a month-long geological cruise to Frobisher Bay, Hudson Strait, Ungava Bay and the Labrador Slope (Brian MacLean, BIO) (Cruise 90-023). This cruise included participants from Queens University, University of Montreal, University of Colorado, Northern Illinois University, University of Wisconsin, Bates College and the Geological Survey of Canada (GSC). The main purpose was to investigate the record of glacial events in various regions but with emphasis on Hudson Strait. Samples were collected principally by means of the long AGC piston corer supplemented by box cores, IKU and van Veen grabs. Bottom photography and plankton tows were also collected. Acoustic profile data were obtained using the Hunttec DTS and a high-resolution seismic reflection system to delineate the extent of stratigraphic units while sidescan sonar was used to provide data on the modification of seafloor sediments by ice and other factors. Acoustic profile and magnetometer data were also collected to provide data on the underlying bedrock. At the completion of the program, *Hudson* returned to BIO.

Next was a geological cruise to the Gulf of St. Lawrence (Heiner Josenhans, BIO) (Cruise 90-028). The objectives were to obtain long piston cores of sediments of Quaternary age within the Gulf Region and collect high-resolution seismic and sidescan sonar data at the core sites. The cruise was primarily intended to obtain ground truth information at interesting sites identified in earlier seismic cruises. Equipment used included the long piston corer, Hunttec DTS, airgun, sidescan sonar, IKU grab, box corer and bottom camera. A visit was made to the Saguenay Fjord before the cruise terminated in Quebec City, QC.

The last cruise of the year carried out further geological studies in the Gulf of St. Lawrence, Cabot Strait and Laurentian Channel (Gus Vilks, BIO) (Cruise 90-031). It involved participants from the University of Windsor and the University of Quebec. The purpose was to study the late glacial and post-glacial sedimentary and oceanographic history of the Gulf of St. Lawrence, Cabot Strait and Laurentian Channel by running seismic surveys and collecting sediment cores and bottom grabs. Equipment used included an airgun, Hunttec DTS, long AGC piston corer, box corer, Lehigh corer and van Veen grab. At the completion of the program, *Hudson* returned to BIO to end yet another busy and productive year.



Available cruise stations/tracks for 1990

1991

The *Baffin* was decommissioned after 34 years of service, primarily as an offshore hydrographic survey vessel. To partially make up for her loss, the *Mathew* was transferred to BIO from the Newfoundland and Labrador Region. As a result, time on *Hudson* was to be made available to CHS every second year for hydrographic surveys, especially up north.

Cruises

Captains: Loran Strum/John Lewis

Number of Cruises: 9

Days at Sea: 210

Nautical Miles Steamed (Reported): 32,424

The first cruise was in early April to the northwest Atlantic which involved participants from Dalhousie, the Freshwater Institute and the Scripps Institution of Oceanography (SIO) (Glen Harrison, BIO) (Cruise 91-001). This was the third BIO cruise in support of the international Joint Global Ocean Flux Study (JGOFS) which was studying the spring phytoplankton bloom. This year, three primary locations were chosen for study: one in Roseway Bay off Yarmouth in a phytoplankton rich zone, one east of the Gulf Stream in phytoplankton poor waters and one intermediate between the two in slope water to establish a gradient of biological conditions. Three days were spent at each location. The previous two cruises stressed various plankton process studies identified by JGOFS

as core measurements. However, this cruise was organized principally as an optics cruise to test and evaluate a number of new sophisticated instruments for measuring submarine light fields and related biological and physical properties of seawater. These instruments were deployed on two vehicles. The OPTIPROBE included two fluorometers, a spectral light meter and an optical zooplankton counter while BUD was a free-fall microscale turbulence instrument with fluorometers and light meter attached. The timing of the cruise was perfect and caught the spring bloom in early or full development at all three locations. The optical studies did not accomplish as much as expected but the process studies went very well. Visiting scientists added some very interesting experiments on nutrient-limitation bioassays and characterization of sub-micron particles. In addition, preliminary experiments were carried out on the size characterization of biomass and carbon and nitrogen utilization by picoplankton. A new analyzer for the measurement of dissolved organic carbon (DOC) was also tested and performed well.

Next was a physical, chemical and biological oceanographic cruise to the northwest Atlantic and southern Labrador Sea which was divided into two legs with a changeover in Qaqortoq (Julianehaab), Greenland (Ross Hendry, BIO) (Cruise 91-007). Also participating were scientists and engineers from Dalhousie, the USSR State Oceanographic Institute and several instrumentation companies. There were numerous objectives. The first was to contribute to the international World Ocean Circulation Experiment (WOCE) hydrographic program by occupying selected hydrographic sections in the western North Atlantic and southern Labrador Sea to provide the observations required to develop models for predictions of climate change. The sections would also allow regional studies of circulation and the associated transports of heat and freshwater in the western North Atlantic. The second objective was to contribute to both the World Ocean Circulation Experiment (WOCE) and the international Joint Ocean Global Flux Study (JGOFS) by measuring natural and anthropogenic chemical species dissolved in seawater in conjunction with the hydrographic measurements. The third objective was to contribute to the JGOFS goal of better understanding the role of biological production in the global carbon cycle. A fourth objective was to examine the origins of a range of biogenic halomethanes found in the atmosphere by measuring their distribution in the water column. In addition, sea trials were carried out for several new oceanographic instruments and the CTD measurements were compared to those of a simultaneous USSR survey conducted in the Newfoundland Basin. Good weather and the absence of major equipment breakdowns led to generally successful results for all program components. A total of 130 CTD stations were occupied and over 2,600 discrete water samples collected. However, severe ice conditions off the Labrador coast made sampling there impossible. A unique wide-ranging set of biological and physical measurements were obtained in intensive spring bloom conditions. *Hudson* returned to BIO at the end of the cruise.

Next was a multidisciplinary earth science cruise to the continental slope, Fogo Seamounts and Flemish Cap with participants from Memorial, McGill, University of Virginia and Seastar (David Piper, BIO) (Cruise 91-020). The purposes were to carry out regional mapping of the deep water margin off the Grand Banks, assess the importance of gas hydrates on the continental slope and in the Flemish Pass, obtain core samples for dinoflagellate distributions and transfer functions, understand the sedimentological

behaviour of the Albatross well site debris flow, make measurements of *in-situ* pore pressure in various deep water sediments, dredge volcanic rock samples from the Fogo seamounts, obtain stratigraphic cores on the outer Flemish Cap and Grand Banks, carry out site surveys of potential Ocean Drilling Program (ODP) sites on the Fogo seamounts and test some new equipment. Data collected included 1,200 km of sleeve gun seismics, 500 km of Hunttec DTS, 12 piston cores, seven box cores, five dredge hauls, nine heat flow stations, 23 gravity cores and nine van Veen grabs. The cruise was most successful with many scientific highlights and ended in St. John's, NL.

This was followed by another geological cruise to the Cabot Strait and Grand Banks with participants from Dalhousie, the Technical University of Nova Scotia and Seastar (F. Marrillier, DAL) (Cruise 91-027). The objectives were to conduct deep seismic studies of Appalachian structures and carryout an offshore/onshore experiment as part of the Canadian Lithosphere Program. Equipment used included a large airgun array and ocean bottom seismometers. *Hudson* returned to BIO at the completion of the program,

Next was a geophysical cruise to Baffin Bay and Nares Strait (Ruth Jackson, BIO) (Cruise 91-039). Also involved were scientists and engineers from Memorial, Waterloo, Dalhousie, the Nova Scotia Institute of Technology and Seastar. Projects carried out included a crustal refraction program to investigate the sedimentary and crustal structure of northern Baffin Bay and southern Nares Strait, underway gravity, magnetics and bathymetry to complement the seismic data and to extend regional coverage, box and piston coring in northern Baffin Bay to study the oceanographic and paleoclimatic conditions, box coring in Thule Harbour to monitor the effects of a plane crash in 1968 that carried nuclear war heads, a shallow seismic reflection study in the southern Nares Strait to investigate glacial and surficial geological history and a high-resolution seismic survey off Baffin Island near Clyde River to map debris flows to provide modern base line studies to be used as analogues in the ancient environments. Seismic data were collected with an airgun and Hunttec DTS. Partway through a port call was made at Thule, Greenland to exchange personnel and calibrate the gravity meter. The cruise was very successful with most objectives attained. Data collected included 10,974 km of bathymetry, 14,466 km of gravity, 7,995 km of magnetics, 808 km of seismic refraction, 1,580 km of seismic reflection, 22 box cores and 13 piston cores. The cruise ended in Goose Bay, NL.

Next was a cruise to Lake Melville on the Labrador coast to carry out the Arctic Delta Failure Experiment (ADFEX) (Jaia Syvitski, BIO) (Cruise 91-033). Also participating were staff from Memorial, IKB Technology, University of Calgary, Canada Centre for Inland Waters (CCIW), Laval, Institut National de la Recherche Scientifique (IRNS) Oceanology and Seakem. The purpose of ADFEX was to generate a mesoscale submarine slide and monitor its behaviour in order to better understand the geological implications of this common form of sediment redistribution on the seafloor, a process of great interest to the developing offshore oil and gas industry. Planning for this experiment began in 1987 and involved extensive consultation with the nearby Innu community of Sheshatshiu and DFO Habitat Management. Field camps were set up and launches used to help deploy equipment which included seismics, sidescan sonar, corers,

grabs, CTD, water bottles and cameras. The experiment proved to be an operational success. All pre and post geophysical and geological surveys were carried out, over 50 oceanographic moorings were placed and retrieved and thirty-two 30-foot explosive holes were drilled, armed with dynamite and detonated. Representatives of both the Innu community and DFO were on hand for the detonation. As predicted, the experiment proved to be environmentally benign. Habitat was protected and no fish were killed. However, unfortunately the detonations failed to produce the desired underwater slide but it was hoped that a second attempt could be made in the future. The cruise terminated in Goose Bay, NL.

Next was another geological cruise to the Labrador Sea and North Atlantic which was divided into two legs (Claude Hillaire-Marcel, UQAM) (Cruise 91-045). This was entirely a university operation organized by the University of Quebec at Montreal. The purpose of the first leg was to carry out on shore-off shore transects to intercalibrate geochemical and micro-paleontological productivity-paleoproductivity indicators as part of the Paleoproductivity of the Labrador Sea Project. This was a contribution to the Canadian Joint Global Ocean Flux Study (JGOFS) program. The major objectives were to define the relationships between climatic fluctuations at the time scale of the glacial/interglacial transition, the primary productivity and carbon fluxes in the Labrador Sea and the organic activity in the water column and surface sediments responsible for early diagenic mineralization processes. The purpose of the second leg was to identify the geochemical tracers of the past and modern North Atlantic Deep Water Current in water and sediments. This included sampling in the Labrador Sea and the Irminger and Iceland basins. Sampling included various corers, van Veen grabs, CTD and water samples. The cruise was most successful and terminated in St. John's, NL.

This was followed by a physical oceanographic cruise to Grand Banks with numerous objectives (Fred Dobson, BIO) (Cruise 91-055). The first goal was to provide an *in-situ* calibration and validation of the European Space Agency's ERS-1 satellite radar sensors which included a synthetic aperture radar (SAR), a radar altimeter and scatterometer. These sensors together provided information on wavelength, wave direction, wave height, sea surface elevation plus wind speed and direction. Work on *Hudson* included shipboard meteorological and marine wave radar measurements as well as processing meteorological and wave data transmitted from an array of moored buoys. This was done in parallel with overflights of the Canada Centre for Remote Sensing (CCRS) Convair-580 aircraft carrying various sensors. This experiment was done in the area of the Virgin Rocks which was one of the primary crossover areas of the descending and ascending passes of ERS-1. Activities on *Hudson* were centered around the ERS-1 overpass times. The second goal was to use a bow-mounted fast-response anemometer and thermistor system in conjunction with the wave measurements to investigate and define in high sea states a relationship between the wind stress on the sea surface and the air-sea heat transfer rate and the state of development of the sea. The third goal was to provide a data base at specific grid points of the Atmospheric Environment Service (AES) operational wave forecast model in order to verify and improve its forecasting capabilities. The fourth goal was to improve the ability of marine radars to measure the length, direction and height of open ocean waves at all sea states during rain and to compare their

capabilities with those of airborne and space-borne sensors. The fifth goal was to utilize the HF radar operated by Newfoundland Radar Systems Limited at Cape Race to make comparisons with surface current measurements by the Ametek-Straza Acoustic Doppler Current Profiler (ADCP) on *Hudson* and wave measurements by the buoys and space-borne, air-borne and ship-borne radars. Despite some equipment malfunctions, overall the cruise was most successful and produced reams of valuable information. Upon completion of the program, *Hudson* returned to St. John's, NL.

The last cruise of the year was to the Grand Banks and Labrador Sea for physical oceanographic studies (Peter Smith, BIO) (Cruise 91-059). The objectives were to deploy the Canadian Atlantic Storms Project (CASP) II mooring array near Hibernia, conduct a CTD survey of the area, carry out drifter studies along the inshore edge of the Labrador Current and run Batfish and Acoustic Doppler Current Profiler (ADCP) transects across the Labrador Current to compare with synthetic aperture radar measurements made by the Canada Centre for Remote Sensing Convair-580 flying overhead along the same track. The mooring array consisted of six conventional subsurface moorings, two surface anemometer moorings and a pitch-and-roll buoy. Exceptionally high seas were encountered during the cruise. Except for the loss of two drifters, the work went reasonably well and upon completion of the program *Hudson* returned to BIO.



Available cruise stations/tracks for 1991

1992

Oil production began at the Cohasset-Panuke Project (Copan) on Sable Island Bank, heralding Canada's first offshore oil project. Due to over fishing, the northern cod

population on the Grand Banks collapsed and a groundfish fishing moratorium was established.

This year marked the retirement of *Dawson* from the BIO fleet after 24 years of service. However, she was replaced by her sister ship *Parizeau* which was transferred from the DFO Institute of Ocean Sciences (IOS) on the west coast. She had the same capabilities as *Dawson* so BIO seagoing programs were fortunately not affected.

Cruises

Captains: Loran Strum/F.R. Berchem

Number of Cruises: 11

Days at Sea: 228

Nautical Miles Steamed (Estimated): 36,252

The first cruise of the year was to the northeast Newfoundland Shelf which included participants from Memorial (C-CORE) and the French Institute for Ocean Science (IFREMER) (Charles Tang, BIO) (Cruise 91-061). The purpose was to collect oceanographic and sea-ice data for ice dynamics and thermodynamics studies, deploy a RDI Acoustic Doppler Current Profiler, provide support for collaborative programs of other research labs and conduct a joint experiment with the Russian research ship *Akademik Shouleykin*. A helicopter was used to find suitable ice floes for drifting stations and to deploy instrumentation.

This was followed by a geological cruise to Sable Island Bank to investigate sediment transport processes (Carl Amos, BIO) (Cruise 92-001). The day after sailing, a severe winter storm passed through the area which generated waves as high as 7.5 m. In addition to the usual geological sampling equipment, the instrumented mooring RALPH was used to collect high-resolution information of seabed processes. RALPH had been lost on a previous cruise but fortunately was recovered using large ground line as a lasso. Near-bed tidal flows and wind-driven currents were measured. Sidescan sonar surveys showed that the storm created hummocky megaripples in a region previously mapped as featureless. This cruise generated a wealth of new information and understanding of sediment transport processes on Sable Island Bank which subsequently contributed to the development of a sediment transport numerical model called SEDTRANS.

Next was another geological cruise, this time to the Scotian Shelf and Slope (Dale Buckley, BIO) (Cruise 92-003). Several students from Dalhousie and TUNS participated. The primary purpose was to carry out a series of experiments to evaluate the performance of a redesigned large diameter piston coring system in sediment at different locations. In addition, a differential global positioning system (DGPS) was evaluated along with the Track Point II acoustic ranging system. The sampling of sediments was designed to determine areas of accumulation and geochemical alteration of sedimentary organic matter. Equipment used included Hunttec DTS, a sleeve gun seismic reflection profiling system, sidescan sonar, Excaliber and other corers and grabs. This cruise provided an excellent opportunity to carry out further studies of pockmarks in

Emerald Basin sediments. These depression features imply seepages or venting of fluids from the seabed. As a result of this work, it was concluded that the pockmarks are produced by the venting of subsurface fluids and gases. A preliminary map of their distribution was subsequently prepared. The cruise was most successful. The new excellent navigational and instrument positioning capability which was demonstrated made it now possible to carry out surveys and experiments not previously possible. For example, it was possible to return repeatedly to the same pockmark, only 100 m wide, and to place instruments or collect samples within it.

This was followed by a physical oceanographic cruise back to the Grand Banks and Labrador Sea (Peter Smith, BIO) (Cruise 92-010). The scientific objectives were to measure the water circulation and dispersion near Hibernia, study the dynamics of the Labrador Current, evaluate the capabilities of satellite (ERS-1) and airborne (CCRS) synthetic aperture radar (SAR) to detect surface shear in the Labrador Current, evaluate the relationships between wind speed, wind stress, directional wave spectrum and satellite and airborne SAR imagery and test some prototype instrumentation. The CASP II (Canadian Atlantic Storm Program) moorings deployed the previous year near Hibernia were recovered and another CTD survey conducted in the area. Surface drift buoys were deployed and tracked on the inshore edge of the Labrador Current and Acoustic Doppler Current Profiler (ADCP)/Batfish transects were run coincident with SAR overflights of the CCRS Convair-580 aircraft and the ERS-1 satellite. Most of the objectives were accomplished and the cruise ended in St. John's, NL.

The next cruise was back to the Labrador Sea for more physical oceanography which included participants from the University of Göteborg, University of Washington and the Scripps Institution of Oceanography (SIO) (John Lazier, BIO) (Cruise 92-014). The prime purpose was to occupy a large number of CTD Rosette stations as part of the international World Ocean Circulation Experiment (WOCE). The CTD acquired temperature, salinity and oxygen profiles. The rosette water samples were analyzed for salinity, oxygen, nutrients, CFC-11, CFC-12, CFC-113, total carbonate, alkalinity and halocarbons. No floats or moorings were set. Unfortunately, permission was not received to work within Greenland's economic zone so the eastern end of the WOCE line could not be completed. The cruise ended back at BIO.

Next was a geophysical cruise to the Flemish Cap and Newfoundland Basin organized in collaboration with numerous French scientists from the French Institute for Ocean Science (IFREMER), GENAVIR and LGSM (Shiri Srivastava, BIO) (Cruise 92-022). The objectives were to map the subsurface crustal structure across the continental margin off the east coast of Canada, northeast and southeast of Flemish Cap and to carry out detailed surveys at three proposed Ocean Drilling Program (ODP) sites located in the Newfoundland Basin. Bathymetric, gravity and magnetic data were collected throughout the cruise. Two different types of airgun systems were used for the seismic reflection surveys as well as four ocean bottom seismometers. Partway through the cruise, an unscheduled port call was made into St. John's, NL. At the start of the cruise there was concern about its success because *Hudson* had never before been used for deep multi-

channel seismic operations and many new operations were going to be attempted. However, the cruise was most productive and produced some very exciting information.

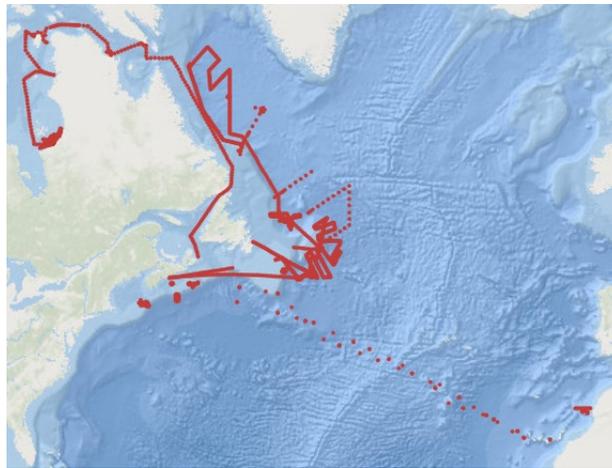
This was followed by a geological cruise to Hudson Bay which was divided into two legs (Carl Amos/Brian MacLean, BIO) (Cruise 92-028). The purpose of the first leg was to collect geological, geodynamical, geochemical and biological information which was required to evaluate the environmental impacts of Hydro-Quebec's proposed Grande Baleine hydroelectric power generation project. This leg ended at Kuujjuaripik (Great Whale River), QC. The second leg involved participants from the Institut Maurice-Lamontagne, Dalhousie, Acadia University, University of Colorado and the University of Wales. The program included water sampling in Hudson Bay to identify zones of upwelling, deployment of IML current meter moorings at six localities in northern Hudson Bay and geological sampling and surveying at selected priority localities in Hudson Strait. Sediments were sampled by means of piston, box and gravity corers and the IKU grab. The Huntec DTS was used to generate high-resolution seismic reflection data and performed very well. In addition, sidescan sonar was used to generate information on seafloor surface features. There was no nurse on board so time was lost for a port call to Povungnituk, QC to treat a medical emergency. Also, during the cruise *Hudson* ran hard aground off Kuujjuaripik, QC but was able to free herself on the following rising tide. A hull inspection indicated no damage so the program was able to proceed. Overall the cruise was most successful and ended at BIO.

As part of the international Joint Global Ocean Flux Study (JGOFS), biologists undertook a trans-Atlantic cruise between Halifax and Morocco to investigate primary and secondary production processes in the upper ocean and their role in the global ocean carbon cycle (Glen Harrison, BIO) (Cruise 92-037). This was a cooperative venture between Canadian, Portuguese, Italian, German, Spanish, Moroccan and South African scientists. Dalhousie and UBC were also involved. The Canadian contributions to the Joint Global Ocean Flux Study (JGOFS) have concentrated on the distribution and biomass of marine microbes, parameterization of their productivity rates and the use of remote sensing techniques to make regional and global scale estimates of these processes. This was the fourth major JGOFS cruise carried out by BIO and the first to work in the eastern North Atlantic. The program employed various state-of-the art techniques to characterize the bio-optical properties of surface waters, the biomass and productivity of marine phytoplankton and other microbes, zooplankton and instruments to study details of the atmospheric/ocean sulphur cycle. The cruise had three operational components. Top priority was the studies carried out during transit to Morocco and return to characterize large ocean basin scale variations in properties. Continuous underway measurements were made using the AquaShuttle equipped with CTD, fluorometer and optical zooplankton counter. Approximately eight days were spent in Moroccan coastal waters doing process studies at drift stations located in active upwelling zones. In addition, a hydrographic section normal to the Moroccan coast was sampled in conjunction with the German research vessel *A.v. Humboldt*. Each of the three components was completed with a high degree of success.

Next was a geological cruise to the Labrador Slope and Flemish Cap organized in collaboration with Memorial (R. Hess, McGill) (Cruise 92-045). The purpose was to carry out seismic reflection surveys and collect sediment by coring.

Following was a cruise to the Gulf of St. Lawrence for the annual ice forecast survey (Bob Lively, BIO) (Cruise 92-050). The primary purpose was to obtain temperature and salinity data from 77 stations for preparation of seasonal ice predictions by the Ice Climatology Branch of the Atmospheric Environmental Service (AES). In addition, dissolved oxygen, nutrient and phytoplankton data were collected. The cruise was most successful.

The last cruise of the year was to the Gulf of St. Lawrence for more JGOFS plankton studies (B. Klein, UQAR) (Cruise 92-051).



Available cruise stations/tracks for 1992

1993

Cruises

Captain: Loran Strum/John Lewis

Number of Cruises: 8

Days at Sea: 152

Nautical Miles Steamed (Estimated): 24,168

The first cruise of the year was to the Canary Basin in the eastern Atlantic Ocean (Neil Oakey, BIO) (Cruise 93-053). This cruise was run in cooperation with the Woods Hole Oceanographic Institution (WHOI), Dalhousie and the University of Victoria. It also involved collaboration with the RRS *Darwin* from the UK. The cruise marked the end of the North Atlantic Tracer Release Experiment (NATRE) which was an international study of the rate of mixing and dispersion of ocean waters in the eastern North Atlantic being conducted by scientists from the US, UK and Canada as part of the World Ocean Circulation Experiment (WOCE). This experiment began in May 1992 when the WHOI

vessel RV *Oceanus* injected a tracer into the water column, 139 kg of sulphur hexafluoride at a depth of 300 m in an area about 20 x 20 km. The evolution of the dye patch was observed in the fall of 1992 on two cruises of the RV *Oceanus*. The purpose of this cruise was to find and survey the extent of the tracer after one year, measure the microstructure within the tracer patch with EPSONDE, find and recover the drifter floats deployed in the tracer patch in May 1992, deploy and recover a microstructure mooring, deploy and recover a Cartesian diver float several times and conduct some biological sampling in preparation for the following cruise. The cruise was most successful and terminated at Las Palmas in the Canary Islands to exchange personnel.

This was immediately followed by a biological cruise off northwest Africa for further JGOFS plankton biomass and productivity studies (Glen Harrison, BIO) (Cruise 93-002). This cruise was the fifth major Canadian expedition contributing to the international Joint Global Ocean Flux Study (JGOFS) and a follow-up to the *Hudson* trans-Atlantic cruise the year before. This cruise also represented a cooperative research venture between DFO and the Joint Research Centre (JRC) in Ispra, Italy which provided generous research funding and was represented onboard by two scientists. It also included participants from Dalhousie, the University of British Columbia, the University of Delaware, Argentina, Chile and Morocco. The scientific program was similar to that in 1992 and employed various state-of-the-art *in-situ* and *in-vitro* techniques to characterize the bio-optical properties of the upper ocean. These included spectral irradiance profiles as well as the distribution, biomass and productivity of marine phytoplankton and other microbes. The cruise had two operational components: survey and drift-station studies in the upwelling zone off the coast of Morocco and daily station work during transit from the coast of Morocco back to Canada. Late departure from Las Palmas forced the cancellation of most of the planned survey work. However, initial CTD work revealed no evidence of upwelling in the initial region selected and, after further water measurements, an alternate location off Western Sahara was chosen for the upwelling work.

Surprisingly, upwelling at this location was also at a minimum. Apparently, the timing of the cruise coincided with a 'relaxation' phase of the normal upwelling situation. Nevertheless, studies were continued at both this location at the edge of the broad continental shelf and in shallow waters on the shelf. Work on transit back to BIO was similar to that done in 1992. This included continuous underway measurements using AquaShuttle and daily station work to characterize large, ocean basin-scale variations in bio-optical properties. AquaShuttle was equipped with a CTD and fluorometer for surveying the upper 150 m of the water column but unfortunately this sampling tool had to be abandoned due to hardware failures which could not be repaired on board. The station work employed a CTD Rosette, biological pump and nets for various *in-vitro* process studies. Despite the loss of operational days due to delays in leaving Las Palmas and the AquaShuttle failure, the cruise was judged a scientific success.

Next was a geological cruise to Sable Island Bank which involved scientists from South Korea, UK, Argentina, US and China (Carl Amos, BIO) (Cruise 93-016). This marked the beginning of a detailed study of seabed sediment stability and scouring in the vicinity of the Cohasset/Panuke development site which was co-sponsored by Lasmo Nova Scotia Ltd. The purpose was to undertake detailed geological surveying to prepare detailed

seabed maps which were needed for the development of numerical models of sediment transport, recover and redeploy seabed instrumentation including current meters, RALPH and SOBS, undertake physical measures of sediment transport and bed stability, deploy Sea Carousel at strategic locations, collect sub-bottom records using the Hunttec DTS, collect sidescan sonar imagery of the seabed, collect vibracores for stratigraphic evaluation, collect numerous IKU and van Veen grabs and take seabed photographs. Navigation was based on the new AGC Navigation System (AGCNAV) which employed differential GPS. All operations went well and the cruise terminated in Sydney, NS.

The following cruise returned to the Labrador Sea for further physical oceanographic studies (John Lazier, BIO) (Cruise 93-019). Participants from the University of Göteborg, the University of Washington and the Lamont-Doherty Earth Observatory were involved. The primary aim was the annual occupation of the AR7W line across the Labrador Sea as part of the World Ocean Circulation Experiment (WOCE). A large number of CTD Rosette stations were occupied. The Seabird CTD acquired temperature, salinity and oxygen profiles while rosette water samples were analyzed for salinity, oxygen, nutrients, CFC-12, CFC-113, total carbonate, alkalinity, halocarbons, tritium and helium. A hull-mounted Acoustic Doppler Current Profiler (ADCP) was operated while the ship was underway between stations. Heavy ice over the Greenland continental shelf prevented the completion of the three stations at the eastern end of the line. In addition, an Acoustic Doppler Current Profiler (ADCP) mooring was deployed for a year on the Labrador Shelf as part of a BIO program to study the movement and stresses of drifting pack ice. Upon completion of work, *Hudson* returned to BIO.

Next was a chemical oceanography cruise to the North Atlantic, Greenland Sea and Norwegian Sea (Phil Yeats, BIO) (Cruise 93-027). This was the second large-scale survey of contaminants in the Atlantic Ocean sponsored by the Intergovernmental Oceanographic Commission (IOC). The first survey was conducted in 1990 using the MV *Meteor* from Germany. A large number of international participants were involved from Florida State University, University of Hawaii, Old Dominion University, Massachusetts Institute of Technology, University of Delaware, Universite Aix-Marseille, Bundesamt für Meereskunde, University of Göteborg, Netherlands Institute for Sea Research and the University of Southampton. The objectives were to measure trace metal and trace organic contaminant concentrations at two IOC baseline survey stations in the northern part of the North Atlantic and to determine trace contaminant concentrations in the northern source waters for deep North Atlantic water masses. Fourteen stations were occupied including twelve in the North Atlantic and one each in the Greenland and Norwegian Seas. In addition, surface samples were collected while *Hudson* was in transit between stations. Strict sampling procedures were followed to ensure consistency with the previous cruise and included a CTD Rosette fitted with Go-flo bottles, plastic-coated hydrowire with Go-flo bottles and an *in-situ* pump. Some analyses were done on board using three clean lab containers while others were done later ashore. Great pains were taken to avoid ship-derived contamination. Overall, the sampling went very well but the final word on the success of the cruise would not be known until the shore-based analyses were completed and all data interpreted. The cruise terminated in Reykjavik, Iceland.

Next was a geological cruise to the Denmark Straits and fjords on the east coast of Greenland (Jaia Syvitski, BIO) (Cruise 93-030). It continued the efforts of a large team of scientists from Geomar (Germany), Icelandic Marine Institute, Virginia Institute of Marine Sciences, Institute of Arctic and Alpine Research (INSTAAR), Office of Naval Research, University of Calgary and the Geological Survey of Canada. It was designed to contribute to several international programs including the Polar North Atlantic Margins (PONAM), a high-resolution seismic study of glacial continental shelves (COLDSEIS) and the Paleoclimate of Arctic Lakes and Estuaries (PALE) project which was part of the International Geosphere/Biosphere Program (IGBP) PAGES global change investigation. Topics investigated included the role of turbidity currents and debris flows in fjord sediment transport, the role of iceberg/sea ice shelves fronting larger tidewater glaciers and their effect in controlling sedimentary processes within fjords, the role of iceberg calving and rafting on sediment accumulation distal from the ice margins and the role of sub-glacial sediment transport through fjords and onto the continental slope during periods of ice sheet expansion. Sampling equipment included a digital seismic system, sidescan sonar, various corers and seabed cameras. Oceanographic measurements in the water masses were also made. In addition, launches were used for nearshore work and to transport shore parties.

One of the planned operations was to collect piston cores of bottom mud at the head of the Kangerlugsuaq Fjord on the east coast of Greenland which had only been lightly investigated by Danish research vessels. The fjord is 33 nautical miles long and at the time 20 % of its area contained various sizes of icebergs. It took four hours to reach the head of the fjord during which a heavy snowfall initiated a short-lived freeze up of the surface waters of the fjord. Intended piston cores, water samples and ROV transects were successfully collected without incident. An additional coring site near the entrance to a branch of the main fjord was deemed safe enough to attempt although this area was infested with freeze-up ice formed during the previous night with a 30 % coverage of icebergs and bergy bits. Unfortunately, once underway *Hudson* hit a hard piece of ice amidships on her starboard side. The area of impact was below the waterline, just forward of the main engine control room, and a fifteen-foot crack was created in the ship's hull. Approximately 120 tons of seawater poured in and the ship quickly listed about eleven degrees to starboard. The crew quickly mustered to address the emergency and the situation was soon stabilized and brought under control.

Hudson now faced the dilemma of being disabled at the head of a desolate ice-infested Greenland fjord far from home. Many communications were exchanged with authorities ashore as the ship sat idly assessing the situation and waiting for assistance. After 35 hours, the Danish naval frigate HMNS *Triton* arrived at the outer fjord to render assistance. Her helicopter flew in to assess the situation. The pilots were quite surprised that *Hudson* had actually made it in as far as she did due to the ice conditions. After several flights back and forth, divers from *Triton* were brought in to assess the damage and it was decided that the ship could make her way out of the fjord under her own power. After scouting out the best route by helicopter, the *Hudson* took 5.5 hours to navigate out of the fjord with ice-free smooth sailing that allowed the collection of

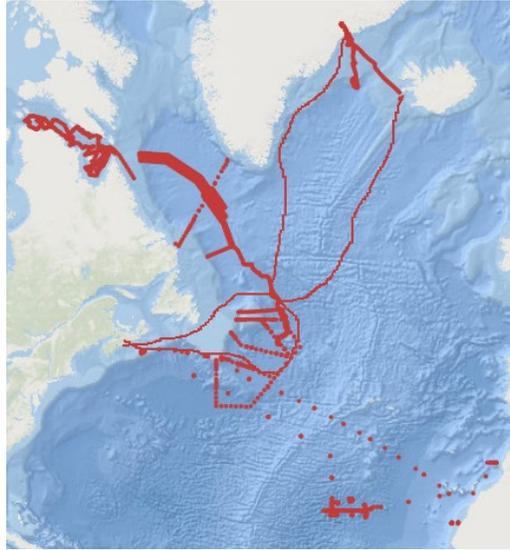
seismic records of the fjord sub-bottom. The ship recovered instrument moorings placed at the mouth of the fjord, and after further inspection by the divers was deemed safe to proceed to Reykjavik, Iceland under the escort of *Triton*. Upon arrival, a special dinner was held on board with the new-found Danish friends to express appreciation of their able assistance.

While in Reykjavik, inspections were carried out and crack arrestors were put in place at the ends of the damaged area by divers. Also, the decision was made for all non-essential scientific staff and crew members to leave the ship and fly back home. Then, with a skeleton crew of about 15, *Hudson* sailed for St. John's, NL where she safely arrived after an uneventful three-day passage. Here she was dry-docked, further repairs were carried out and she was back in service by mid-October. This was probably the most potentially serious situation *Hudson* ever encountered in her long career at sea. Despite the setback caused by the ice damage, the cruise collected excellent data making significant contributions to all projects.

Next was a geological cruise to Hudson Strait and Ungava Bay involving scientists from the University of Montreal and the University of Colorado (Brian MacLean, BIO) (Cruise 93-034). The objectives were to delineate the late Quaternary geology and history of the region, including paleoceanographic data pertaining to global change, by means of surveys with towed systems and by sediment coring and grab sampling. In addition, accurate gravity data were collected in Ungava Bay for precise geoidal definition which was needed for accurate satellite navigational positioning. Data on the earth's gravity and magnetic fields were also collected where feasible in Hudson Strait. Hudson Strait and Ungava Bay were key regions in studying the geologically recent Laurentide Ice Sheet. The record of paleoceanographic conditions contained in the sediment sequences in Hudson Strait was considered to be an important source of information on global change during the last 12,000 years. Equipment used included the Huntec DTS, airgun, sidescan sonar, magnetometer, gravity meter, various cores and various grabs. The cruise terminated at BIO.

The last cruise of the year was for physical oceanographic work in the Newfoundland Basin region which involved participation from the University of Rhode Island (Allyn Clarke, BIO) (Cruise 93-039). This was the second of four cruises to this region in support of the World Ocean Circulation Experiment (WOCE) Control Volume Experiment. The general purpose was to study the interaction between the Gulf Stream and the North Atlantic and Labrador currents and the transport of heat, fresh water, mass and chemical tracers including anthropogenic CO₂ to the south and east of the Grand Banks. This was accomplished by occupying a series of oceanographic stations across these currents from the Tail of the Banks to Flemish Cap and by releasing 41 RAFOS profiling floats at various locations within the North Atlantic Current. A total of 103 full-depth CTD Rosette stations were occupied and water samples were analyzed for CFC's, carbon tetrachloride, total carbonate, alkalinity, oxygen, salinity and nutrients. In addition, 600 hours of Acoustic Doppler Current Profiler (ADCP) and 4,400 km of deep sea bathymetric data were collected while underway. Although three days were lost due

to weather, most of the objectives were obtained and at the completion of the program *Hudson* returned to BIO after another busy year.



Available cruise stations/tracks for 1993

1994

Cruises

Captains: John Lewis/James Dockrill

Number of Cruises: 7

Days at Sea: 143

Nautical Miles Steamed (Estimated): 22,737

The first cruise of the year was to the Grand Banks for multidisciplinary studies (Eugene Colbourne, NAFC) (Cruise 94-002). This was the first *Hudson* cruise organized entirely by the DFO Newfoundland and Labrador Region. The objectives were to carry out a temperature, salinity, density, oxygen and chlorophyll survey of the Grand Banks, conduct a high resolution current mapping of the study area using a vessel-mounted Acoustic Doppler Current Profiler (ADCP), collect water samples for chlorophyll, oxygen and biological analyses and conduct vertical plankton net tows. Water sampling was done using a CTD Rosette equipped with Niskin bottles. The cruise terminated at St. John's, NL but *Hudson* immediately sailed back to BIO after unloading.

This was followed by another cruise to the Labrador Sea (John Lazier, PCSB) (Cruise 94-008). It included participants from the Institute of Ocean Sciences (IOS), Dalhousie, University of British Columbia, BDR Research, Lamont-Doherty Earth Observatory, University of Washington and the Massachusetts Institute of Technology. There were two primary objectives. The first was to conduct the annual CTD survey of the AR7W line across the Labrador Sea from Labrador to Greenland as part of the World Ocean Circulation Experiment (WOCE) program. The second objective was to carry out

various biological observations as part of the international Joint Global Ocean Flux Study (JGOFS) program. These included optical measurements, measurements of primary production, zooplankton studies and studies of stable isotopes of nitrogen and carbon in organic matter. While underway between stations, water velocity profiles were measured using a hull-mounted Acoustic Doppler Current Profiler (ADCP) and the temperature, salinity and chlorophyll of surface water was recorded using a pump plus CTD and fluorometer. Heavy ice over the Labrador Shelf prevented the completion of the inner most six stations and recovery of an Acoustic Doppler Current Profiler (ADCP) mooring deployed on Hamilton Bank in 1993. Unfortunately a new instrument for measuring the fine scale vertical distribution of temperature, conductivity, fluorescence and light spectra called BUD Probe was lost due to a malfunction of the winch upon recovery. Otherwise the cruise was most successful and terminated in Sydney, NS.

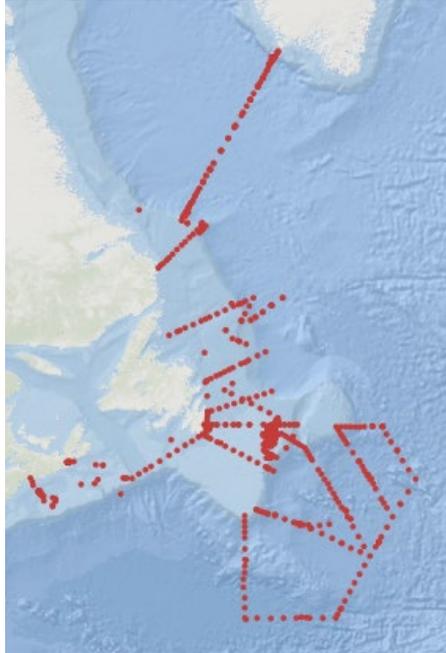
Following was a cruise to the Gulf of St. Lawrence, Cabot Strait and the Scotian Shelf (Bert Klein, Laval) (Cruise 94-016). This was organized by the Interuniversity Group for Oceanographic Research in Quebec (GIROQ) and involved the participation of Dalhousie, Memorial, the Institut Maurice-Lamontagne (IML), the Institut national de la recherche scientifique (INRS), McGill, Laval, University of Quebec at Rimouski (UQAR), University of Quebec at Montreal (UQAM) and the University of Delaware. The general objective was to make further Canadian contributions to the international Joint Global Ocean Flux Study (JGOFS) which was seeking to better understand the ocean carbon cycle and the role of oceans in global carbon cycles. The specific objectives of this cruise were to determine the biologically-mediated export of carbon from the euphotic zone, establish a relationship between the production of large phytoplankton cells and hydrodynamics, quantify the importance of microzooplankton for the regeneration of nutrients and its effects on the growth of large phytoplankton cells, determine the influence of herbivory and bacterivory by microzooplankton, mesozooplankton and pelagic tunicates on the vertical flux of organic matter and study the processes that affect and control burial and regeneration of carbon and associated nutrients in recent sediments. Sampling gear included a CTD Rosette, various sediment traps and corers, a turbulence profiler and assorted plankton nets. Partway through a personnel change took place in Sydney, NS. When work was completed *Hudson* returned to BIO.

The following cruise was to the Newfoundland and Labrador shelves for physical oceanographic studies (Savi Narayanan, NAFC) (Cruise 94-017). The many objectives were to recover twelve current meter moorings and deploy eight new ones, recover an Acoustic Doppler Current Profiler (ADCP) mooring for BIO, deploy a mooring for Memorial, deploy two satellite-tracked drifters for the US Coast Guard, carry out a temperature, salinity, density, oxygen and chlorophyll survey along the NAFO transects on the Newfoundland and Labrador shelves, conduct a high resolution current mapping of the study area using a vessel-mounted Acoustic Doppler Current Profiler (ADCP), collect water samples for chlorophyll, oxygen and biological analysis and conduct vertical plankton net tows. Partway through a port call was made in Cartwright, NL to exchange personnel. The cruise terminated at BIO.

Next was a cruise to the Laurentian Channel for geological studies which included several contractors and students from Dalhousie and Acadia universities (Al Grant, BIO) (Cruise 94-027). The objectives were to map pockmarks in the Laurentian Channel using sidescan sonar, the Hunttec DTS and sleeve gun seismic systems, collect cores, Videograb and Excaliber samples within and adjacent to selected pockmarks and analyze fluids and gasses contained in these samples.

Next was a geological cruise which was divided into two legs (Cruise 94-021). The first leg was to the Hibernia area on the Grand Banks (Gary Sonnichsen, BIO). The objectives were to map and characterize shallow seabed sediments within the foundation zone and within trenching/excavation depths for offshore structures, identify seabed and subsurface instabilities and features which may impact engineering development in areas of offshore hydrocarbon discoveries and determine the distribution and severity of iceberg scour features. Equipment used included the Hunttec DTS, sleeve gun reflection seismics, sidescan sonar, Vibracorer, Videograb and the University College of North Wales geophysical sled. The second leg went to Emerald Basin (Bill MacKinnon, BIO) to test a multi-channel seismic array for the Department of National Defence (DND) and conduct tests on a fixed reference piston core.

The final cruise of the year was back to the Newfoundland Basin for further physical oceanographic studies (Allyn Clarke, BIO) (Cruise 94-030). Scientists from the University of Rhode Island and the Shirshov Institute of Oceanology were involved. The main purpose was to occupy a series of oceanographic stations across the Labrador Current, Gulf Stream and the various branches of the North Atlantic Current from the Tail of the Banks to Flemish Cap. Twenty-seven RAFOS floats, provided by the University of Rhode Island, and five Electric Field Floats (EFFs), provided by the University of Washington, were deployed at various locations. In addition, the prototype underway profiling CTD system under development at BIO was successfully tested. This system collected upper ocean CTD profiles while the vessel was underway and was used along the sections in order to better define frontal structures in association with the float releases. This work represented the second occupation of this station grid and the third deployment of RAFOS floats. The program was in support of the World Ocean Circulation Experiment (WOCE) Control Volume Experiment which was directed at determining the exchange of water between the sub-tropical and sub-polar gyres of the North Atlantic. A bottom sounder and Acoustic Doppler Current Profiler (ADCP) were also operated throughout the cruise. The cruise was most successful with all aspects of the program achieving their basic goals.



Available cruise stations for 1994

1995

Up until this time, the management of BIO research vessels was the responsibility of the Science Sector of the Department of Fisheries and Oceans (DFO). However, this responsibility was now taken over by the Canadian Coast Guard when it was transferred from the Department of Transport (DOT) to DFO and the various fleets were merged in order to achieve efficiencies. Soon after, the science vessels, which had traditionally been painted white, were painted red and white according to Coast Guard practice. Even the builder's models in the BIO lobby were painted the new colours. The science vessels were now identified as Canadian Coast Guard Ships (CCGS).

As part of this reorganization, the Coast Guard lay day system for crewing was introduced. Up until now there had been just one full-time crew on *Hudson* who were at sea for most of the field season and they worked under a system of three watches with four hours on and eight hours off. Under this new lay day system, *Hudson* now had two separate crews which rotated every 30 days. Each crew was divided into two watches which served six hours on and six hours off. While more costly, this new system gave the crews more time off and improved shipboard morale immensely. While now operated by the Coast Guard, the *Hudson's* scientific program was still managed by DFO Science and continued without interruption. However, there were numerous issues with the transfer of resources which took a while to resolve.



CCGS Hudson (BIO Photo Unit)

Since the very beginning of academic oceanography in Canada, universities did not have to pay for ship time on federal government research vessels. However, this practice ended at this time due to the shortage of financial resources. Universities were now forced to seek funding for their ship time from granting agencies or industry.

The Atlantic Geoscience Centre (AGC) became the Geological Survey of Canada, Atlantic (GSCA).

To facilitate the production of the extensive oil reserves, a Gravity Base Structure (GBS) was constructed in Come-by-Chance, NL and installed at Hibernia by Mobil.

DGPS was now available on *Hudson* for navigation so the accuracy of positioning was now on the order of just a few meters, a vast improvement over celestial navigation practiced in the early years.

Cruises

Captains: Anthony Croft/Richard Smith

Number of Cruises: 7

Days at Sea: 187

Nautical Miles Steamed (Estimated): 29,733

The first cruise was to the Newfoundland Basin for further physical oceanographic studies (Allyn Clarke, BIO) (Cruise 95-003). Scientists from the Woods Hole Oceanographic Institution (WHOI), the University of Rhode Island and the Shirshov Institute of Oceanology were also involved. The purpose was to study the interaction between the Gulf Stream and the North Atlantic and Labrador currents and the transport of heat, fresh water, mass and chemical tracers including anthropogenic carbon dioxide to the south and east of the Grand Banks of Newfoundland. A series of oceanographic stations crossing these currents was occupied from the Tail of the Banks to Flemish Cap. In addition, the North Atlantic current meter mooring array deployed by RV *Oceanus* in

August 1993 was recovered. This was the first time that an Acoustic Doppler Current Profiler (ADCP) was mounted on the CTD Rosette frame in order to obtain full depth velocity profiles at each CTD station. This was the final of four cruises to this region in support of the World Ocean Circulation Experiment (WOCE) Control Volume Experiment. The tracer work involving CFC's, carbon tetrachloride, total carbonate, alkalinity and nutrients was in support of the Joint Global Ocean Flux Study (JGOFS). Eighty-eight full depth CTD stations were occupied and six current meter moorings were recovered. The moving vessel profiler (MVP) CTD was successfully tested. The cruise was most successful and the basic goals were achieved. The change to a six hour watch cycle as part of the new lay day system made it much easier to schedule and complete long and complex operations such as mooring recovery.

Next was a geological cruise to the Cabot Strait and Cape Breton Channel (Heiner Josenhans, BIO) (Cruise 95-006). This cruise was part of a continuing program to study the surficial geology of the Gulf of St. Lawrence. Specific objectives included defining seafloor stability and strength, determining the rate of seafloor erosion in areas of strong bottom currents, defining the maximum lowering of late glacial sea levels and extent of drowned river valleys cut by lowered sea levels, studying the frequency of pockmark occurrence and rate/mechanism of current erosion and investigating the palaeography and seabed processes which have shaped the Gulf of St. Lawrence region throughout the last 13,000 years. Work focused on a proposed cable route from Newfoundland to Nova Scotia. Equipment used included the Huntec DTS, airgun, sidescan sonar, Vibracorer, piston corer, IKU grab, bottom camera and bottom current meters. Some nearshore sampling in Aspey and Searsten bays was done using a launch. On the way back to BIO, *Hudson* passed through the locks in the Canso Causeway.

Next was another physical oceanographic cruise to the Labrador Sea and the North Atlantic (John Lazier, BIO) (Cruise 95-011) which also involved participation from the Lamont-Doherty Earth Observatory, the Woods Hole Oceanographic Institution (WHOI), Scripps Institution of Oceanography (SIO), the University of Washington and the University of Rhode Island. The prime objective was the annual occupation of the World Ocean Circulation Experiment (WOCE) AR7W line across the Labrador Sea to monitor the water mass properties. A second objective was to recover the NOAA/ACCP-funded mooring in the centre of the central gyre which had been deployed in May 1994. The purpose of this mooring was to obtain data throughout the year to better understand the formation of Labrador Sea Water and the variability in its properties induced by interannual variations in the heat and salt fluxes. In addition, three deep Lagrangian floats and three ALACE floats were successfully launched in the Labrador Sea. Further testing was successfully done on seven casts with the moving vessel profiling CTD system currently under development, but unfortunately the instrument was lost during recovery. The cruise ended in St. John's, NL.

Next was a biological cruise to the Newfoundland Shelf, Labrador Sea, North Atlantic and Scotia Shelf with participants from Dalhousie (Glen Harrison, BIO) (Cruise 95-016). This was part of the continuing Joint Global Ocean Flux Program (JGOFS) program. The primary objective was to map the broad scale distribution of phytoplankton,

zooplankton and their physical-chemical environment in these different regions. Sampling equipment included a CTD Rosette, the biological pumping system and the optical particle counter (OPC) vertical profiling system.

Next was a long cruise to Rankin Inlet in Hudson Bay (Paul Davies, CHS Central Region) (Cruise 95-020). The sole purpose was to carry out a standard hydrographic survey to collect bathymetric data for the production of a nautical chart for safe deep-draft shipping. Four hydrographic launches and a helicopter were used. Partway through the cruise a crew change was carried out in the town of Rankin Inlet, NWT. Work went well and at the completion of the program *Hudson* returned to BIO.

This was followed by a geological cruise to the Scotian Shelf, Gulf of Maine and Bay of Fundy which was divided into two legs (Gordon Fader/Bob Courtney, BIO) (Cruise 95-030). The purpose of the first leg was to assess selected areas on the Scotian Shelf for their resource aggregate potential. Sampling included seismic reflection, sidescan sonar, grabs, cores and seabed photographs. All objectives were met with the exception of collecting subsurface samples of granular materials with the Vibracorer. Fifty stations were occupied and 41 large volume grab samples were collected. The data collected were of high quality. These samples were later processed under contract to determine their potential for use in concrete, asphaltic concrete and other specialized industrial applications and the results were quite encouraging. The purpose of the second leg was to collect ground-truthing information for the verification of multibeam bathymetric data on Emerald Bank. Sampling equipment included seismic gear, piston corer, IKU grab and the Excalibur bottom sampler.

The last cruise of the year was to the Laurentian Fan and Sable Island Bank (David Piper, BIO) (Cruise 95-033). The many objectives included collecting sidescan sonar and high-resolution seismic data near the Thebaud platform, deploying RALPH at various locations to collect information on seabed dynamics, collecting seabed samples for grain size analysis, collecting sediment samples using a Vibracorer and IKU grab for facies and stratigraphy analysis, collecting piston and gravity cores for the assessment of Holocene variations in storminess and improving the regional core-top dinoflagellate data base.

With the transfer of BIO ships to the Coast Guard, the long-standing tradition of the cooks on *Hudson* providing seafood chowder for the BIO Christmas party came to an unfortunate end. Despite considerable lobbying, the Coast Guard would not reverse this decision. However, the Christmas party organizing committee made arrangements directly with Hans Lejune, an ex-*Dawson* cook, to continue to supply the chowder for many years.



Available cruise stations/tracks for 1995

1996

The Canada Oceans Act received Royal Assent. This ambitious Act made Canada the first nation in the world to have comprehensive oceans management legislation.

Significant changes, driven by a major program review of all federal government programs in Canada, were made in the organization of BIO which now had a new science director and management structure with eight research divisions. Staff from most of the previous PCSB divisions and the BSB Biological Oceanography Division were merged to form the new Ocean Sciences Division (OSD) while the Habitat Ecology and Marine Chemistry divisions were merged to create the new Environmental Sciences Division (ESD).

Cruises

Captain: Leslie Rhodenizer

Number of Cruises: 7

Days at Sea: 175

Nautical Miles Steamed (Estimated): 27,825

The first cruise of the year was to the Labrador Sea (John Lazier, BIO) (Cruise 96-006) in support of the international World Ocean Circulation Experiment (WOCE) program which aimed to elucidate the circulation of the North Atlantic at all depths throughout the water column. Because the Labrador Sea was a known site of oceanic deep convection, it had been chosen as a region of special study. The purpose was to carry out the annual CTD survey of the Labrador Sea which had been initiated in 1966.

This was followed by a cruise to the Scotian Shelf, Cabot Strait and Laurentian Channel which involved participants from the Institut Maurice-Lamontagne (IML), Dalhousie and the University of Toronto (Michel Mitchell, BIO) (Cruise 96-010). The primary objective was to survey phytoplankton and zooplankton distributions along lines across

the Cabot Strait and Laurentian Channel and extending seaward across the shelf from Louisbourg and Halifax. Sampling was done using a CTD Rosette, Batfish, BIONESS and ring nets. In addition, tests were conducted of a multi-frequency acoustic sonar system designed to assess the abundance of macro-zooplankton and pelagic fish, experiments were conducted on zooplankton feeding and reproduction as part of the newly established international Global Ocean Ecosystems Dynamics (GLOBEC) program and studies of carbon dioxide production in marine plankton were carried out. While running the transects, an Acoustic Doppler Current Profiler (ADCP) was run continuously to record the back-scattering levels of microzooplankton. Surface water was pumped continuously through the hull to monitor chlorophyll and nutrient concentrations. This cruise laid the ground work for the development of the Atlantic Zone Monitoring Program (AZMP) which was formally established a few years later in 1998.

Next was a multidisciplinary cruise to the Gulf of St. Lawrence, St. Pierre Bank and Scotian Shelf which involved participants from Dalhousie, McMaster and the University College of Cape Breton (Gary Bugden, BIO) (Cruise 96-014). The various objectives included obtaining temperature, salinity, oxygen and nutrient data from the cod-redfish study area and climate monitoring sections, servicing two current meter moorings in Cabot Strait, deploying a new current meter mooring with guard buoys on the southern flank of St. Pierre Bank, collecting O₁₆/O₁₈ samples for Lamont-Doherty Earth Observatory's continuing climatic studies, collecting strontium isotope and dissolved inorganic carbon samples in support of cod otolith studies, collecting continuous atmospheric mercury samples for the Atmospheric Environment Service (AES), carrying out plankton tows, collecting deep water samples for the preparation of certified reference material for seawater nutrients by the National Research Council (NRC) and comparing two instruments for measuring dissolved oxygen in seawater. Thirty-nine of the planned 41 stations were fully completed. Only the two outermost Halifax Sections could not be occupied within the allotted time.

This was followed by a return cruise to Hudson Bay and Rankin Inlet for further hydrographic surveying (P. Davies, CHS Central Region) (Cruise 96-016). The purpose was to collect bathymetric data for the production of nautical charts. This was the second year of a two-year program. Four hydrographic launches and a helicopter were again used. In addition, some seabed samples were collected by van Veen grab. Partway through the cruise a visit was made to the village of Rankin Inlet, NWT for a staff change. The cruise terminated in Churchill, MB.

Next was a geophysical cruise to Ungava Bay and along the coast of Labrador (Ian Reid, BIO) (Cruise 96-021). Participants included the Danish Lithospheric Centre and Dalhousie University. The purpose was to conduct further studies of the deep oceanic crust using an airgun and ocean bottom seismometers.

This was followed by a fall physical oceanographic cruise back to the Labrador Sea (Allyn Clarke, BIO) (Cruise 96-026). Work included setting a large number of current

meter moorings, acoustic sources, acoustic tomography moorings, subsurface and surface drifters and a large meteorological buoy to monitor conditions over the coming winter.

The final cruise of the year was to the Scotian Shelf and Laurentian Fan for further geological studies (Carl Amos, BIO) (96-029). The objectives included determining the evolution, stability and internal structure of shore-faced connected ridges southwest of Sable Island through sampling and instrumentation, determining the sediment transport pathways and processes which influence this transport at key sites over the shore-faced connected ridges using RALPH, monitoring bedload transport using Halley-Smith sediment traps in conjunction with RALPH, determining the depth of the mobile layer along the inshore Mobil pipeline route alternative using the IKU grab, collecting sidescan sonar and seismic data along the alternate pipeline route for comparison to the 1995 survey results, carrying out a sidescan sonar survey along the western pipeline route and collecting long core and seismic data in the region of the Laurentian Fan.



Available cruise stations/tracks for 1996

1997

Oil production began at Hibernia. This was the first oil production development on the Grand Banks.

This year marked the retirement of *Parizeau* from the BIO research vessel fleet. This loss significantly increased the demand for ship time on *Hudson* for offshore research programs.

This was the last year that *Hudson* was used for conducting hydrographic surveys for Arctic and offshore regions which were no longer a priority for the Canadian Hydrographic Service (CHS).

Cruises

Captains: Leslie Rhodenizer/Don Shea/James Dockrill

Number of Cruises: 9

Days at Sea: 199

Nautical Miles Steamed (Estimated): 31,641

The first cruise of the year was back to Sable Island Bank for further sediment transport studies (Carl Amos, BIO) (Cruise 97-001). The general objectives were to determine seabed stability of Sable Island Bank for purposes of gas pipeline construction and determine the origin and character of shoreface connected ridges on the Bank. Specific objectives were to determine the evolution, stability and internal structure of shoreface-connected ridges through sampling and instrumentation, determine the sediment transport pathways, modes of transport and the processes which influence this transport at key sites using RALPH, monitor bedload transport using Halley-Smith sediment traps, determine the depth of the mobile layer along the proposed Mobil pipeline routes using the large IKU grab, collect sidescan and seismic data along the proposed pipeline route to compare with the results of the 1995 survey and carry out a sidescan survey of the gutters found in the shoreface immediately south of Sable Island in order to determine their origin.

Next was a biological and physical cruise to the Scotian Shelf, Cabot Strait and St. Pierre Bank (Erica Head, BIO) (97-003). The purposes of the biological program included conducting CTD, nutrient, oxygen, phytoplankton and zooplankton surveys along five transects as part of a long term ocean climate monitoring program under development, measure egg production rates of zooplankton in relation to *in-situ* food concentration and composition and measure underwater light profiles. The transects sampled were the Cabot Strait, Louisbourg, Halifax, Roseway and Cape Sable lines. Sampling equipment included a CTD Rosette, ring nets, BIONESS, a vertical profiling optical particle counter (OPC) and a biological pumping system. The purpose of the physical program was to carry out Acoustic Doppler Current Profiler (ADCP) measurements, recover two current meter mooring arrays and deploy three new ones in the Cabot Strait and off St. Pierre Bank. Near the end, a short port call was made at Sydney, NS to exchange scientific personnel.

Next was a physical and biological cruise to the Scotian Shelf and Labrador Sea (Allyn Clarke, BIO) (Cruise 97-009). Participants included scientists from the Institut Maurice-Lamontagne (IML), Old Dominion University and the Institut für Meereskunde. The objectives were to carry out a physical, chemical and biological occupation of the Halifax Section, occupy a series of oceanographic stations across the Labrador Sea as part of the Atlantic Circulation Experiment of the World Ocean Circulation Experiment (WOCE), carry out a biological and chemical program within the Labrador Sea in support of the Joint Global Ocean Flux Study (JGOFS), recover and reset two current meter moorings off Hamilton Bank, recover the meteorological buoy deployed by *Hudson* in 1996 at weather station Bravo, recover the profiling CTD mooring set for the Woods Hole

Oceanographic Institution (WHOI) near weather station Bravo and recover two acoustic transceiver moorings and one profiling CTD mooring set earlier for the Institut für Meereskunde. Subsurface Lagrangian floats were also deployed at various locations along the CTD transects. The JGOFS program included the measurement of light radiance, primary productivity, dimethyl sulphide, zooplankton and organic carbon. At completion of the program, *Hudson* returned to BIO.

This was followed by a geological and biological cruise to the Bay of Fundy and Browns Bank (Gordon Fader, BIO) (Cruise 97-020). The major purpose of the first phase was to determine if modern acoustic methods could improve the mapping of horse mussel beds in the upper Bay of Fundy. Additional objectives were to map sediments in the Bay, define the subsurface stratigraphy, determine the glacial and sea level history, assess dynamic conditions of sediment transport and assess the aggregate potential of seabed sediments. Geophysical surveys were conducted with sidescan sonar, Huntec DTS and sleeve gun seismic systems. Biological and geological sampling was carried out with a variety of sampling equipment including Videograb which allows precise sampling of seabed features. After a brief personnel exchange in Saint John, NB, *Hudson* proceeded to Browns Bank to carry out a geophysical survey to obtain information of sediment distribution and features identified in a multibeam bathymetric survey conducted the year before. The seabed was found to be quite complex and variable. Particular attention was given to comparing the distribution of scallops in relation to sediment properties. Enroute to Browns Bank, a piston core was collected to understand the final ice surge from the Bay to the Gulf of Maine. The cruise was most successful. Weather was excellent and all equipment worked well.

Next was another cruise to Hudson Bay for hydrographic surveying in Chesterfield Inlet and Narrows, Whale Cove and Arivat (P. Davis, CHS Central Region) (Cruise 97-033). It was divided into two legs with a crew change partway through in Rankin Inlet, NWT. The purpose was to conduct hydrographic surveys for deep draft shipping, which supplied fuel and goods to the Keewatin communities of Arivat, Whale Cove and Chesterfield Inlet and to determine depths in Chesterfield Narrows. Four hydrographic launches and a helicopter were employed. Some bottom samples were collected with a van Veen grab. The cruise terminated in Churchill, MB.

Next was a geological cruise in Hudson Strait and the Labrador Sea which involved participants from McGill, University of Quebec, University of Colorado and the University of Delaware (David Piper, BIO) (Cruise 97-048). The many objectives were to survey and core seamounts on the North Atlantic Mid Ocean Channel (NAMOC) sandy braid plain to establish the thickness of the turbidity currents that deposited the sands and obtain a long stratigraphic record of outburst and Heinrich events (sedimentation from melting icebergs), to obtain three long piston cores from the plume facies south of Hudson Strait outlet in order to interpret plume sedimentology, carry out reconnaissance of the continental slope off Hudson Strait to make comparisons with the Laurentian Fan, ground-truth earlier SeaMARC data, fill in critical gaps in the seismic coverage of the North Atlantic Mid Ocean Channel (NAMOC) system in order to facilitate work on the modelling of levee sequences, obtain a few long stratigraphic cores

for further work on Heinrich events, obtain better seismic coverage of several potential Ocean Drilling Program (ODP) sites, carry out reconnaissance seismic and coring work on the Newfoundland Drift route to scope out the potential for a historical record of flow intensity in the North Atlantic Current and improve the data base of core-top microfossil distribution. Equipment used included seismic gear, various corers, current meter and sediment trap moorings and CTD Rosette.

This was followed by another geological cruise to the Cape Breton area and Gulf of St. Lawrence (Heiner Josenhans, BIO) (Cruise 97-058). The primary objectives were to define the maximum low stand of post-glacial sea level and to map the surficial seabed geology. In addition, seismic surveys were conducted in enclosed basins in order to identify core sites to define the existence and age of drowned lakes. Equipment used included AGCNAV, Huntec DTS, piston core, IKU grab, Vibracorer and an underwater camera/video system. Inshore work was done off Cheticamp, Louisbourg and Gabarus, NS.

Next was a multidisciplinary cruise to the Scotian Shelf and Cabot Strait which involved Dalhousie (Michel Mitchell, BIO) (Cruise 97-063). The primary objectives were to survey the zooplankton and phytoplankton distributions on the Scotian Shelf and across the Cabot Strait using Batfish, multi-frequency acoustics, BIONESS, ring nets and water samples, to collect CTD profiles and conduct Batfish transects across the Scotian Shelf and Cabot Strait, to monitor the water structure and its relationship to fish larvae and copepod retention on Western Bank and conduct various equipment trials. An Acoustic Doppler Current Profiler (ADCP) was run continuously to record volume back-scattering along all the transects. The transects sampled included the Halifax, Louisbourg and Cabot Strait lines. Despite inclement weather, all the primary objectives were successfully achieved.

The final cruise of the year was to the Grand Banks which included scientists from the UK Southampton Oceanographic Centre (Fred Dobson, BIO) (Cruise 97-069). The many objectives included equipping the Atmospheric Environmental Service (RRS) NOMAD meteorological buoy moored near Hibernia with sufficient wave and motion sensors to analyze the output of its meteorological sensors for the effects of high sea states, equipping the NOMAD buoy with turbulence sensors and determining the feasibility of using such a system to measure the air to sea fluxes of momentum and heat, comparing the fluxes measured by the buoy with those measured on *Hudson*, comparing the meteorological data collected by the NOMAD buoy with similar data collected by other nearby buoys and *Hudson* and standing by the RRS meteorological buoy moored on the southwest Grand Banks for at least six hours to compare its readings to those collected by *Hudson*. In addition, during specific overpass times of the Radarsat and ERS-2 satellite-borne SAR systems and the SEA-WIFS optical systems, comparing the wind and wave measurements from the buoys and the ship with estimates from the SAR systems, using the Hibernia platform and *Hudson* as targets to further delineate the ship detection capabilities of the Radarsat SAR and preparing operational marine and wind and wave forecasts for the area of the platform using available data and verifying the forecasts

against the measured data. The bottom sounder and an Acoustic Doppler Current Profiler (ADCP) were operated throughout the cruise while steaming.



Available cruise stations/tracks for 1997

1998

The Coast Guard proposed replacing *Hudson* with the *Edward Cornwallis*, a high endurance multi-tasked light icebreaker, but after further study this proposal was dropped.

This year marked the formal beginning of the Atlantic Zone Monitoring Program (AZMP), a major long-term monitoring program created jointly by the Quebec, Maritimes and Newfoundland and Labrador Regions of DFO. The purpose was to collect the physical, chemical and biological oceanographic field data needed to characterize and understand the causes of oceanic variability at seasonal, interannual and decadal scales, to provide multidisciplinary data sets which could be used to establish relationships among the physical, chemical and biological variables and to provide adequate data to support the sound development of ocean activities and policy. This program was designed to provide DFO with the information necessary to detect, track, and predict changes in the productivity and state of the marine environment which was essential to understanding both present and future important issues such as the impacts of climate change. The data gathered were envisioned to support sound ecosystem management with the aim to conserve and protect the marine environment and resources for future generations. It was also intended that the data collected would be used to assist the development of predictive numerical models of the marine ecosystems of Atlantic Canada. A major product of this program was to be the production of annual State of the Ocean reports. The first such report was released in 2000 and they have continued uninterrupted since then. The

sampling strategy of this program was based upon sampling sixteen standard sections in representative areas across the Gulf of St. Lawrence and the continental shelf at least once a year. This was to be augmented by higher frequency sampling at more accessible stations in representative areas to monitor the shorter time scale dynamics. Additional fish survey and remote sensing data would provide broader spatial coverage. This new long-term program required extensive ship time and *Hudson* began to be the major vessel used. She was the perfect platform for this multidisciplinary program and all the labs and deck areas were fully utilized.

Cruises

Captains: Martin Marsden/Leslie Rhodenizer
Number of Cruises: 12
Days at Sea: 183
Nautical Miles Steamed (Estimated): 29,097

The first cruise of the year was a return trip to Sable Island Bank for further geological studies of sediment transport in the region of the developing offshore gas project Sable Offshore Energy Project (SOEP) by Mobil (Carl Amos, BIO) (Cruise 98-001). Scientific staff included visitors from Italy, France and New Zealand. The objectives were to deploy RALPH in a region of fine sand to monitor storm sediment transport, attempt to configure a high-resolution seismic system to give penetration, resolution and information through the surficial unconsolidated sands of Sable Island Bank, collect high-resolution seismic profiles through a region of channels, collect box cores in the region of gutters south of Sable Island, tie together five boreholes collected by Mobil over a sand ridge near Thebaud, define the 3-D geometry of the channels and examine the possibility that they are gas escape features, examine the region of specks for evidence of gas escape and examine a crater south of Sable Island to determine its origin. Equipment used included RALPH, IKU grab, Vibracorer, sidescan sonar and Huntec DTS.

Next was a biological cruise to the Scotian Shelf and Cabot Strait which was broken into two legs with a return to BIO partway through to exchange personnel (Erica Head/Doug Sameoto, BIO) (Cruise 98-002). The objectives were to conduct biological sampling for the Canadian contribution to the international Global Ocean Ecosystem Dynamics (GLOBEC) program, repeat CTD, phytoplankton and zooplankton surveys along the Cape Sable, Halifax, Louisbourg and the Cabot Strait lines as part of the new Atlantic Zone Monitoring Program (AZMP), carry out multi-frequency sonar, Acoustic Doppler Current Profiler (ADCP) and optical particle counter (OPC) measurements while underway and test the moving vessel CTD. Equipment used included a CTD Rosette, Batfish, BIONESS, ring nets, vertical profiling OPC and Acoustic Doppler Current Profiler (ADCP).

This was followed by a biological cruise to the northwest Atlantic involving participants from Memorial and the University of Quebec (Maurice Lavasseur, IML) (Cruise 98-006). The prime purpose was to occupy a series of stations in the triangle between Halifax, Bermuda and a station in the North Atlantic Drift as part of the NODEM (Northern

Ocean DMS Emission Models) program. This program included measurements of biogenic dimethyl sulphide (DMS), phytoplankton and zooplankton. Equipment included the surface water pumping system for continuous monitoring of temperature, salinity, fluorescence and nitrate while underway and a CTD Rosette for sampling while on station. Atmospheric aerosol samples were also collected.

Next was a cruise to the Scotian Shelf and Grand Banks to investigate several high profile benthic habitat issues (Don Gordon/Kee Muschenheim, BIO) (Cruise 98-015). This was a continuation of the program initiated earlier by the now retired *Parizeau*. The cruise was divided into two legs with a port call partway through into Louisbourg, NS to exchange personnel. The main objectives of the first leg were to continue the otter trawling impact experiment on Western Bank, initiated in 1997, and beginning a hydraulic clam dredging experiment on Banquereau. The Western Bank work involved coordination with *Teleost* which carried out experimental otter trawling while initiation of the clam dredging experiment on Banquereau involved interaction with the *Atlantic Pursuit*, a commercial clamming vessel operated by Clearwater Fine Foods Ltd. The main objectives of the second leg were to monitor the distribution and effects of hydrocarbon drilling wastes around the Hibernia platform on the Grand Banks and conduct benthic baseline surveys at Terra Nova on the Grand Banks and the Sable Offshore Energy Project (SOEP) on Sable Island Bank. During both legs, the potential of the Quester Tangent QTC View Seabed Classification System as a habitat mapping tool was evaluated. A wide variety of equipment was employed including Campod, Videograb (with DRUMS), BRUTIV, CTD Rosette, the Moored Instrumented Monitoring System (MIMS), the Benthic Organic Seston Sampler (BOSS) and sidescan sonar. Non-BIO collaborators included the Northwest Atlantic Fisheries Centre, Dalhousie, Acadia and Clearwater Fine Foods Ltd. In addition, Ron Grady from Coast Guard Fleet Services in Ottawa was on board for the second leg to observe *Hudson* in operation. He was in charge of the project examining the feasibility of replacing *Hudson* with *Cornwallis* and quickly realized that this would not work. The overall mission was very successful with all major objectives obtained. *Hudson* again proved to be an excellent platform for carrying out such a diverse program of operations.

Next was a multidisciplinary cruise to the Scotian Shelf and Labrador Sea (Peter Jones, BIO) (Cruise 98-023). The objectives were to carry out a physical, chemical and biological occupation of the Halifax Section, occupy the 28 oceanographic stations across the Labrador Sea AR7W Line and carry out a biological and chemical program in the Labrador Sea in support of the Joint Global Ocean Flux Study (JGOFS) which included light radiance, primary productivity, dimethyl sulphide (DMS), zooplankton and carbon system measurements. In addition, five current meter moorings were recovered off Hamilton Bank and two were reset plus two sound source moorings were recovered for the University of Rhode Island. Equipment used included CTD Rosette, ship-mounted Acoustic Doppler Current Profiler (ADCP) and the biological pump. Four containers provided additional laboratory space for on board analytical work.

This was followed by a geological cruise to the Grand Banks and Flemish Pass which involved students from University College of Cape Breton and Saint Mary's University

(Gary Sonnichsen, BIO) (Cruise 98-034). The objectives were to identify geohazards such as shallow gas, faults, glacigenic sediments, seabed iceberg scouring and sediment instabilities that may pose constraints to drilling or development in new oil and gas exploration areas, enhance understanding of the extent and timing of glacial ice advance over northeastern Grand Bank and tie the known shelf stratigraphic framework to the deep water stratigraphy and age control in Flemish Pass. Equipment used included sleeve gun, Huntec DTS, sidescan sonar, Trackpoint II, Quester Tangent seabed classification system (QTC), bottom camera, drift camera and IKU grab. Some work was carried out at Hibernia. This research provided the knowledge base on seabed conditions and geohazards necessary for federal agencies and offshore regulators such as the Canada-Newfoundland Offshore Petroleum Board who must approve development plans for new bottom-founded structures and pipelines off eastern Canada. The cruise was most successful and upon completion of the program *Hudson* returned to BIO.

Next was a geological cruise to the Sohm Abyssal Plain, Newfoundland Ridge and the Scotian Slope with participants from McGill and Saint Mary's (David Piper, BIO) (Cruise 98-039). The objectives were to define the character, extent and age of the subglacial outburst flood through the Laurentian Channel by carefully focused coring and seismic reflection profiling on the Sohm Abyssal Plain, obtain cores near the outlet of the North Atlantic Mid Ocean Channel (NAMOC) to assess long term throughput of sediment to the Sohm Abyssal Plain, carry out a detailed seismic and coring survey of two selected salt diapirs on the Scotian Margin to assess their possible role in gas release and gas hydrate distribution and carry out a small detailed survey of part of the Newfoundland Ridge as a baseline for understanding regional geology and current reworking hazards. Equipment used included seismic gear, piston corer and gravity corer.

This was followed by a geophysical cruise on the Scotian Shelf involving participants from Dalhousie University (Ruth Jackson, BIO) (Cruise 98-042). The purpose was to determine the velocity-depth function of the crust to a depth of about 40 km to improve understanding of the geological structure of the margin and its significance for Appalachian tectonics. In particular, the velocity signature of the middle to lower crust was closely examined for velocity gradients or discontinuities. The velocities were compared with velocities from rare offshore outcrops that sample the deep crust. Two seismic lines were run; one, about 450 km long, was parallel to the Nova Scotian coast along the Eastern Shore and the other was perpendicular and ran offshore for about 150 km. Each line was traversed three times. On the first transect, fourteen digital ocean bottom seismometers (dOBSs) were deployed to record the sound source. On the second transect an airgun array was fired to be recorded by the OBSs which were then recovered on the third transect. Magnetic data were also recorded.

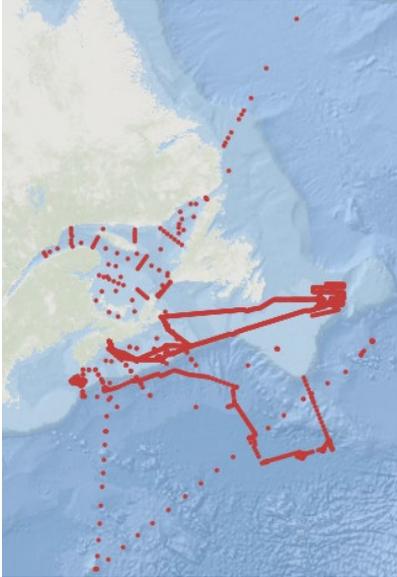
Next was a physical oceanographic cruise to the Grand Banks and St. Pierre Bank (Gary Bugden, BIO) (Cruise 98-047). The objectives were using a CTD Rosette to occupy a grid of 56 stations to obtain temperature-salinity profiles, nutrient, oxygen and stable isotope samples in support of climate and fisheries research, service current meter moorings and guard buoys at two sites on St. Pierre Bank, deploy a new current meter

mooring and guard buoys at a site on the Grand Banks to monitor flow in the Labrador Current and acquire Acoustic Doppler Current Profiler (ADCP) profiles across significant straits and banks while underway.

This was followed by a multidisciplinary cruise to Cabot Strait and the Scotian Shelf (Alex Herman, BIO) (Cruise 98-050). The objectives were to conduct biological sampling for the Canadian Global Ocean Ecosystem Dynamics (GLOBEC) program using BIONESS, carry out further CTD, phytoplankton and zooplankton surveys along the Cabot Strait, Louisbourg, Halifax, Browns Bank and Roseway Bank lines as part of Atlantic Zone Monitoring Program (AZMP), conduct Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements while in transit, conduct Optical Particle Counter (OPC) measurements using Batfish and running equipment trials with the Moving Vessel Profiler (MVP) and vertical opening/closing nets. Partway through the cruise a quick crew change was made at BIO.

Next was a multidisciplinary cruise to the Gulf of St. Lawrence which included participants from Dalhousie and the University of Sherbrooke (P. LaRouche/Alain Gagné, IML) (Cruise 98-069). The objectives were to measure biological and optical properties of the St. Lawrence ecosystem in order to validate remote sensing images and to carry out the annual ice forecasting program. The entire Gulf and estuary were sampled using a large CTD Rosette system. In addition, zooplankton samples were collected with bongo nets, sediment samples were collected for contaminant analysis and two current meter moorings were deployed. The cruise was divided into two legs with a port call at Matane, QC part way through to exchange personnel.

The final cruise of the year was to the Scotian Shelf, Northeast Channel and Georges Bank (Peter Smith, BIO) (Cruise 98-077). The objectives were to conduct time-series measurements of currents, temperature and salinity at key locations for surface layer cross-over flow measurements from Browns Bank to Georges Bank, examine the distribution of temperature, salinity, dissolved oxygen and nutrients on Browns and Georges banks and to make Lagrangian measurements of surface drift on Browns and Georges banks. Eight current meter moorings were deployed on Browns Bank and in the Northeast Channel, a single current meter mooring deployed earlier for the GLOBEC program on Western Bank was recovered and a CTD section was run along the Halifax Line. A total of 39 CTD stations were occupied.



Available cruise stations/tracks for 1998

1999

The Cohasset-Panuke Project (Copan) oil development on Sable Island Bank was decommissioned after just seven years of production. However, the Sable Offshore Energy Project (SOEP) came into operation. It consisted of five different gas fields (Thebaud, Venture, South Venture, North Triumph and Alma) which were connected by pipelines. After processing at the Thebaud platform, gas was piped ashore to Country Harbour.

A Zodiac Hurricane fast rescue craft was installed on *Hudson* which considerably improved the capability to exchange personnel at sea. It appeared that despite her age *Hudson* would continue to be the primary offshore science vessel at BIO for at least another five years. This was welcome news to the oceanographic community.

Cruises

Captains: Leslie Rhodenizer/Martin Marsden/Joe McKenna

Number of Cruises: 13

Days at Sea: 207

Nautical Miles Steamed (Estimated): 32,913

The first cruise was to the Cabot Strait and Scotian Shelf (Michel Michell/ Ed Horne, BIO) (Cruise 99-001). It was divided into two legs with a brief personnel exchange at BIO partway through. The objectives were to carry out further CTD, phytoplankton and zooplankton surveys along the Cabot Strait, Louisbourg, Halifax, Browns Bank and Roseway Bank lines as part of Atlantic Zone Monitoring Program (AZMP), conduct Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements while underway and conduct biological sampling for the Canadian Global Ocean

Ecosystem Dynamics (GLOBEC) program. Ring net tows, BIONESS tows and plankton profiles were also made at selected stations.

Next was a geophysical cruise on the Scotian Shelf with the assistance of Dalhousie University (Ruth Jackson, BIO) (Cruise 99-007). The objectives were to determine the velocity-depth function of the crust to a depth of about 40 km to improve understanding of the geological structure of the margin and its significance for Appalachian tectonics. In particular, the velocity signature of the middle to lower crust was closely examined for velocity gradients or discontinuities and the velocities were compared with velocities from rare offshore outcrops that sample the deep crust. Two seismic lines were run; one, about 450 km long, was parallel to the Nova Scotian coast along the Eastern Shore and the other was perpendicular and ran offshore for about 150 km. Each line was traversed three times. On the first transect, fourteen digital ocean bottom seismometers (dOBSs) were deployed to record the sound source. On the second transect an airgun array was fired to be recorded by the dOBSs which were then recovered on the third transect. Magnetic data were also recorded.

This was followed by another cruise to continue investigating high profile benthic habitat issues on the continental shelf (Don Gordon/Kee Muschenheim, BIO) (Cruise 99-012). The cruise was divided into two legs with a port call into Sydney, NS to exchange personnel. The numerous objectives included concluding the three-year otter trawling impact experiment on Western Bank in collaboration with *Needler*, conducting the second year of sampling for the hydraulic clam dredging experiment on Banquereau, conducting a clam survival experiment on Banquereau in collaboration with the Clearwater vessel *Atlantic Vigour*, measuring the distribution and effects of hydrocarbon drilling wastes around the Hibernia platform on the Grand Banks which included testing a new shellfish mooring, deploying the Moored Instrumented Monitoring System (MIMS) under development, servicing current meters at Hibernia, conducting benthic habitat mapping surveys at the Gully, Haldimand Canyon and the Stone Fence, collecting physical oceanographic and nutrient data in the Gully and investigating the release of produced water at the Panuke production well on Sable Island Bank. AGCNAV was again used for navigation and a new Regulus II survey system was tested. In addition, the potential of the Quester Tangent QTC View Seabed Classification System as a habitat mapping tool was further evaluated and Towcam was successfully tested for the first time as a replacement for BRUTIV for conducting video surveys of the seabed. A wide variety of equipment was employed including Campod, Videograb, BRUTIV, Towcam, CTD, BOSS, IKU grab and sidescan sonar. Unfortunately, Towcam was lost when *Hudson* got too close to the Hibernia platform on a foggy evening and suddenly, without warning, had to reverse the engines which caused the tow cable to be cut. Non-BIO collaborators included the Northwest Atlantic Fisheries Centre, Dalhousie and Acadia. There were also participants from the DFO Oceans Act Coordination Office, Habitat Management Branch, Policy and Planning Branch and the Marine Environmental Data Service (MEDS). In addition, the local artist Susan Feindel was on board to view seabed habitat and organisms first hand and she generated a large number of sketches and paintings which were later shown in local art galleries. With the exception of losing

Towcam at Hibernia, the overall cruise was very successful with all major objectives achieved.



CCGS Hudson at Hibernia (Credit BIO Photo Unit)

Next was a physical oceanographic cruise to the Grand Banks and Scotian Shelf (Gary Bugden, BIO) (Cruise 99-018). The objectives were using a CTD Rosette to obtain temperature-salinity profiles, nutrient, oxygen and stable isotope samples at six stations in support of climate and fisheries research, service current meter moorings and guard buoys on St. Pierre Bank and the Grand Banks, acquire Acoustic Doppler Current Profiler (ADCP) profiles across various straits and banks, including the Louisbourg Line, while underway and field test a new model of the Moving Vessel Profiler (MVP). Unfortunately, a current meter mooring on the Grand Banks could not be recovered, presumably due to damage caused by heavy foreign fishing activity in the area. All other objectives were met.

This was followed by a multidisciplinary cruise to the Scotian Shelf and Labrador Sea which included participants from the Lamont-Doherty Earth Observatory and the University of Rhode Island (Allyn Clarke, BIO) (Cruise 99-022). Operations were carried out in support of three ongoing scientific programs. The first was the Climatic Variability and Predictability (CLIVAR) project which was a component of the World Climate Research Program (WCRP). The occupation of the Labrador Sea section, Line AR7W, and the recovery and replacement of the two Labrador Sea current meter moorings provided a measure of the winter cooling and water mass transformations over the winters of 1998/99 and 1999/2000. The second was the Labrador Sea project of the Canadian Joint Global Ocean Flux Study (JGOFS) program. This biological program was designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions both to determine the role of the biological pump to sequester carbon and to develop the regional algorithms that would allow primary productivity estimates to be made using data from ocean colour satellite sensors such as SeaWifs. The chemical oceanographic program measured total carbonate alkalinity and CFCs over the entire water column in support of these JGOFS objectives. The third objective was to occupy the Halifax Line in support of Atlantic Zone Monitoring Program (AZMP). During this cruise, an Acoustic Doppler Current Profiler (ADCP) was added to the CTD Rosette package to provide an estimate of the full depth velocity profile at each CTD station.

This was the first cruise to use the OSD Ocean Data and Information system (ODIN) for tracking and collecting metadata and water sample data collected during the cruise. The cruise was remarkably free of problems and most objectives were fully achieved.

Next was a geological cruise to the Grand Banks and Flemish Cap to continue the regional assessment of seabed sediments, features and geohazards (Gary Sonnichsen, BIO) (Cruise 99-031). Specific objectives included sidescan sonar surveys to delineate the zone of relict iceberg scouring at depths of 400-650 m, sidescan sonar surveys over glory holes between the Terra Nova and White Rose oil fields, regional seismic profiles in Flemish Pass, coring of identified gas hydrate targets and slope instability features, tie shelf top stratigraphy to deep water cores with established chronology and reconstruct the age, extent and timing of glaciation on the shelf and the role of sea level rise. In addition, the HARP and MIMS moorings deployed earlier near the Hibernia platform were recovered. Equipment used included sidescan sonar, Hunttec DTS, piston corer, van Veen grab, IKU grab, a small ROV and bottom camera. The cruise ended in Sydney, NS.

This was followed by another geological cruise to the Laurentian Channel and Scotian Slope which involved participants from Dalhousie and Saint Mary's (David Piper, BIO) (Cruise 99-036). The scientific objectives were to improve knowledge of the late Cenozoic seismic framework of the Scotian margin including detailed seismic investigation of failure features, determine *in-situ* pore pressures and their relationship to failure features, obtain piston cores for organic geochemistry, pore-water geochemistry to assess gas hydrate presence, Holocene high-resolution stratigraphy, interpretation of failure features and ice margin reconstruction, evaluate deep-towed streamer with surface source, sleeve gun array and modified Excalibur, obtain core top data for dinoflagellate studies and collect water samples from the core of the Western Boundary Undercurrent. Equipment used included various corers and the Hunttec DTS. The data collected showed a remarkable number of shallow faults that reach the seabed surface and appeared to produce localized landslides, perhaps through the release of gas.

Next was a biological cruise to the northwest Atlantic which involved participants from the University of Quebec, Dalhousie, Memorial and the University of South Alabama (Maurice Levasseur, IML) (Cruise 99-043). The purpose was to occupy a series of oceanographic stations as part of the Northern Ocean DMS Emission Models (NODEM) research program. This was the second NODEM cruise. The objectives were to determine dimethyl sulphide (DMS) concentrations and ocean-atmosphere fluxes in the northwest Atlantic and Labrador Sea, determine DMS production and consumption rates over a wide range of *in-situ* temperatures and determine the relative importance of biogenic and anthropogenic sulphur aerosols and their size spectra. While underway, surface water was collected with the pumping system in the forward lab and while on station water column sampling was done using a CTD Rosette. Seven stations were occupied for 24 hours at which Lagrangian surface buoys were deployed and followed to ensure *Hudson* remained in the same water mass. Atmospheric aerosol samples were collected when the ship was steaming upwind. The weather was exceptionally good and no serious problems occurred. The cruise was most successful with almost all objectives achieved.

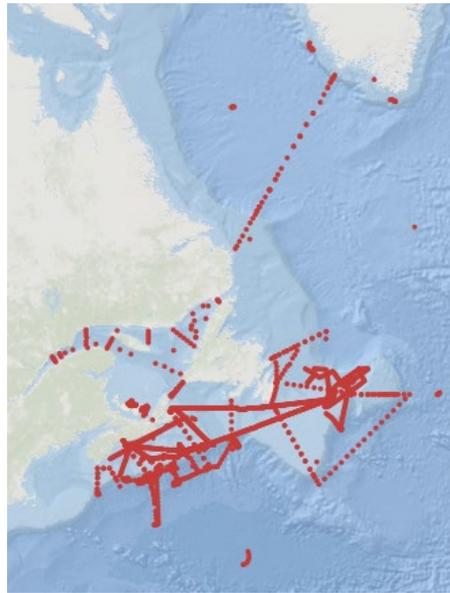
This was followed by geological cruise along the northern and eastern shores of Prince Edward Island (PEI) and to the Northumberland Strait (Don Forbes, BIO) (Cruise 99-049). The objectives were to determine the seaward extent and sedimentary record of transgressed valley systems on the inner shelf off northern and eastern PEI, investigate the dynamics and mobility of seabed sediments across the shoreface as a basis for estimating future rates of shore profile recession under rising sea levels, ground-truth multibeam bathymetric data collected earlier off northern and eastern PEI and obtain high-resolution seismic profiles over a suspected buried salt dome structure between PEI and Cape Breton in support of other work on bedrock geology and crustal dynamics in the region. Equipment used included sidescan sonar, Huntec DTS, various grabs, Vibracorer, seabed cameras, a ROV and RALPH. Because *Hudson* was unable to make water with her evaporators in the coastal region, the program was interrupted partway through the cruise so she could proceed into Charlottetown to take on water. *Hudson* dropped anchor for all coring and ROV operations which proved highly effective in shallow water.

The next cruise was to the Cabot Strait and the Scotian Shelf which was divided into two legs (Erica Head/Michel Mitchell, BIO) (Cruise 99-054). The main purpose was to repeat the surveys along the Cabot Strait, Louisbourg, Halifax, Roseway and Browns Bank lines for the Atlantic Zone Monitoring Program (AZMP). Additional sampling was done on St. Pierre Bank and in the Gully. Other objectives were to measure underwater light profiles to determine photosynthetic/irradiance parameters, Acoustic Doppler Current Profiler (ADCP) measurements of the distribution of krill and small pelagic fish, using BIONESS to collect samples in depth stratified tows to investigate the vertical distribution of zooplankton in deeper waters, further engineering development of the Moving Vessel Profiler (MVP) system and engineering tests with the Vertical Optical Particle Counter (VOPC) and ring nets. Partway through a port call was made back into BIO to exchange personnel.

This was followed by a cruise to the Grand Banks (Eugene Colbourne, NAFC) (Cruise 99-061). The main purpose was to sample standard transects across the Grand Banks during the fall using a CTD Rosette system as part of the Atlantic Zone Monitoring program (AZMP). Variables measured included temperature, salinity, oxygen, chlorophyll and several biological variables. Vertical plankton net tows and Acoustic Doppler Current Profiler (ADCP) surveys were also carried out on each transect. Despite the loss of one day due to ship-related technical problems, all objectives were achieved. This cruise marked the beginning of participation by the Newfoundland and Labrador Region in the newly established Atlantic Zone Monitoring Program (AZMP).

The last cruise of the year was to the Gulf of St. Lawrence in early December (Alain Gagné, IML) (Cruise 99-063). This was the annual ice forecasting cruise and the standard grid of CTD stations was sampled throughout the Gulf and Estuary. Meteorological data were also collected. In addition, CTD Rosette stations were made along six monitoring transects. These were Lower St. Lawrence Estuary, Sept-Iles, Southwest Anticosti, Bonne Bay, Centre and Iles-de-la Madeleine. Water samples were

collected for measurement of chlorophyll, nutrients, oxygen and phytoplankton. Zooplankton were also collected at a few stations with Bongo nets to measure their spatial distribution and interannual variability. Poor weather conditions were encountered at the beginning and end of the cruise so that only 75% of the planned stations could be sampled. This cruise marked the beginning of participation by the Quebec Region, along with the Maritimes and Newfoundland and Labrador Regions, in the newly established Atlantic Zone Monitoring Program (AZMP).



Available cruise stations/tracks for 1999

2000

The drilling moratorium on the Canadian sector of Georges Bank was extended to 2012.

Hudson, now in service for thirty-six years, underwent the first phase of an extensive refit to prolong its working life as the major oceanographic research platform in eastern Canada for another seven to ten years. Consequently, the 2000 field season for *Hudson* did not start until the end of May.

This year marked the beginning of the international Argo Program which was created to collect information on internal ocean dynamics using a fleet of instrumented robotic floats which drifted with the ocean currents and moved up and down between the surface and mid-depth. Launched from a ship, each Argo float spends almost all its life below the surface at a pre-set depth determined by its weight. Every ten days, an internal battery-driven pump transfers oil between a reservoir inside the float and an external bladder which caused the float to first descend to 2000 m and then return to the surface measuring temperature and salinity along the way. The data and the float position are then relayed to satellites and on to receiving stations on shore. After transmitting data, the float sinks again to repeat the 10-day cycle until its batteries are exhausted. These

floats allowed for the first time the measurement of temperature and salinity of the upper 2,000 metres of the ocean in real time and *Hudson* deployed them in large numbers for many years.

Cruises

Captains: Leslie Rhodenizer/Martin Marsden/Richard Smith/Bill English

Number of Cruises: 11

Days at Sea: 168

Nautical Miles Steamed (Estimated): 26,712

The first cruise of the year was to the Scotian Shelf and Labrador Sea to continue global climate studies (Glen Harrison, BIO) (Cruise 2000-009). Scientists from the Institut für Meereskunde and Old Dominion University were involved. The objectives included sampling the Halifax Section across the Scotian Shelf, sampling the AR7W Line across the Labrador Sea from Labrador to Greenland, recovering four German and two DFO current meter moorings, redeploying both sets of moorings and setting a new DFO current meter mooring at the outer end of the Halifax Section. Numerous biological measurements were made as well, including phytoplankton and bacterial productivity. Sampling equipment included a CTD Rosette, a ship-mounted Acoustic Doppler Current Profiler (ADCP), sediment traps, radiometers and plankton nets. This began the second decade of an annual occupation of the Labrador Sea section which provided information on the formation of intermediate and deep water through winter cooling and convection. This was the second cruise to use the new Ocean Data and Information system (ODIN). Due to a week's delay in sailing time, a significant part of the intended program was not accomplished.

Next was a cruise to continue investigating high profile benthic habitat issues on the continental shelf (Kee Muschenheim/Don Gordon, BIO) (Cruise 2000-020). The cruise was divided into two legs with a port call into Sydney, NS to exchange personnel. The numerous objectives included testing the redesigned Towcam towed benthic imaging system, collecting information on produced water discharges at gas platforms on Sable Island Bank, conducting CTD and nutrient surveys in the Gully, studying the distribution of drilling wastes around the Hibernia platform on the Grand Banks, further testing of the Moored Instrumented Monitoring System (MIMS) and shellfish moorings at Hibernia, to observe the impacts of drilling wastes, recovering current meter moorings at Hibernia, conducting the third year of sampling in the hydraulic clam dredge experiment on Banquereau, conducting further benthic habitat mapping surveys in the Gully, measuring the respiration of epibenthic communities, conducting benthic habitat mapping surveys in the Northeast Channel with focus on potential deep water coral habitat, further evaluation of the Quester Tangent QTC View Seabed Classification System as a habitat mapping tools and benthic surveys at the Swissair crash site off Peggy's Cove. A wide variety of equipment was employed including Campod, Videograb (with DRUMS), the new Towcam, CTD, BOSS, IKU grab and sidescan sonar. The new Regulus navigation system was further tested and evaluated. Non-BIO collaborators included the Northwest Atlantic Fisheries Centre, Institut Maurice-Lamontagne (IML), Acadia University,

Memorial University and the University of Rhode Island. In addition there were also participants from the BIO Oceans Act Coordination Office and Habitat Management in Ottawa plus staff from the Transportation Safety Board and the Department of National Defence joined *Hudson* by launch for the surveys at the Swissair crash site. The cruise concluded with an exciting Campod video survey of a sunken submarine off Peggy's Cove. Overall the cruise was most successful with almost all objectives fully met.

This was followed by a lengthy geological cruise which was divided into four legs (Cruise 2000-030). The purpose of the first leg (Michael Li, BIO) was to understand the morphodynamics of sand ridges on Sable Island Bank, collect limited critical data towards understanding the glacial and sea-level history of the region and study the morphologic and stratigraphic characteristics along potential pipeline corridors in deeper waters on Sable Island Bank. Instruments used in this survey included a van Veen grab, IKU grab, Benthos camera, Vibracorer, sidescan sonar and seismic systems and the Hunttec DTS. Sidescan sonar and seismic surveys were run across sand waves, along proposed pipeline routes and across Sable Island Bank. Seabed photos were taken and sediment samples were collected along transects across the sand ridges. The leg terminated in Sydney, NS.

The objectives of the second leg (John Shaw, BIO) were to collect vibracores and piston cores off Cape Breton and southwest Newfoundland to provide information on sea level changes over the past 10,000 years and collect cores at Milne Bank, PEI to determine rates of sediment accumulation. Seismic surveys were also run using the Hunttec DTS. Scientists from McGill participated. At the conclusion of the program, *Hudson* anchored off Souris, PEI for personnel exchange.

The objectives of the third leg (Heiner Josenhans, BIO) in the Gulf of St. Lawrence were to define the location and extent of drowned rivers surrounding PEI and collect seabed samples towards understanding ice margins and sea level history. Work included sidescan sonar and seismic surveys using Hunttec DTS and airgun, bottom photography, van Veen grabs, IKU grabs, piston coring and vibracoring at key locations. Sidescan sonar and seismic regional surveys were also conducted to help establish stratigraphic relationships among glacial and early post-glacial deposits and erosional surfaces. At the end of the work a personnel exchange took place at St. Peters Bay, PEI.

The objectives of the fourth leg (Don Forbes, BIO) were to acquire vibracores in valley fill deposits off St. Peters and Tracadie bays, PEI, collect piston cores in deeper water seaward of Rustico Bay and service a Waverider mooring off Brackley Beach in support of climate change studies. Previously collected multibeam bathymetric data for the area were incorporated digitally into Regulus to guide the selection of sampling stations. The scientific program ended prematurely because of a fire in the engine room which forced *Hudson* to return early to BIO.

This was followed by a geological cruise to the Scotian Shelf and Slope which involved participants from Dalhousie, Saint Mary's and the University of Quebec (David Piper, BIO) (Cruise 2000-036). Work was done in the LaHave Basin and between 200 and

3,000 m on the Scotian Slope. The primary objective was to obtain ground-truth data relating to slope stability for recent multibeam surveys. Other objectives were to investigate techniques for obtaining good quality geotechnical cores, investigate changes in Holocene bottom currents from core samples, collect water samples for suspended sediment analysis from the Western Boundary Undercurrent and sample a particular rock outcrop off Halifax. Equipment used included Hunttec DTS, airgun, piston corer, box corer, rock dredge and bottom camera.

Next was another geological cruise to the Scotian Slope which included a representative from Marathon Oil (Dave Mosher, BIO) (Cruise 2000-042). The objectives were very similar to the previous cruise and focused on collecting information to further understand and document the geological and biological processes that were occurring on the Scotian Shelf. These included obtaining ground-truth data for recent multibeam surveys, investigating techniques for obtaining good quality geotechnical cores, investigating changes in Holocene bottom currents from cores and testing deep-tow seismic reflection equipment over rough seafloor topography. Equipment used included the Hunttec DTS, airgun, piston corer, box corer and IKU grab.

This was followed by yet another geological cruise, this one to the Scotian Shelf, Northeast Channel and Georges Bank (Brian Todd, BIO) (Cruise 2000-047). The primary objective was to collect both geophysical and geological information at depths between 40 and 400 m in areas where multibeam sonar data had been collected by the Canadian Hydrographic Service (CHS) in the past four years, specifically German and Georges banks. Also targeted were deeper areas between the banks including the Northeast Channel and the channel between German and Browns banks. A secondary objective was to collect data to provide ground-truth information for ongoing studies of benthic habitat. In addition, the surveys were designed to contribute to the understanding of the Quaternary evolution of the Scotian Shelf and the associated changes in sea level. Equipment used included Hunttec DTS, airgun, sidescan sonar, IKU grab, van Veen grab, box corer and Campod.

Next was a return cruise to Cabot Strait and Scotian Shelf which was divided into two legs with a port call into BIO partway through to exchange personnel (Ed Horne/ Michel Mitchell, BIO) (Cruise 2000-050). The main objective was to sample the standard Browns Bank, Roseway, Halifax, Gully, Louisbourg, Cabot Strait and Laurentian Channel lines as part of Atlantic Zone Monitoring Program (AZMP). In addition, biological sampling in support of the Global Ocean Ecosystem Dynamics (GLOBEC) program was conducted in the Gully, a Seahorse mooring was deployed and recovered along the Halifax Line and equipment tests were performed on the Moving Vessel Profiler (MVP), vertical opening and closing nets, Batfish and an acoustic calibration system. The usual equipment was used including a CTD Rosette, Acoustic Doppler Current Profiler (ADCP), Batfish, BIONESS, ring nets and vertical profiling Optical Particle Counter (OPC).

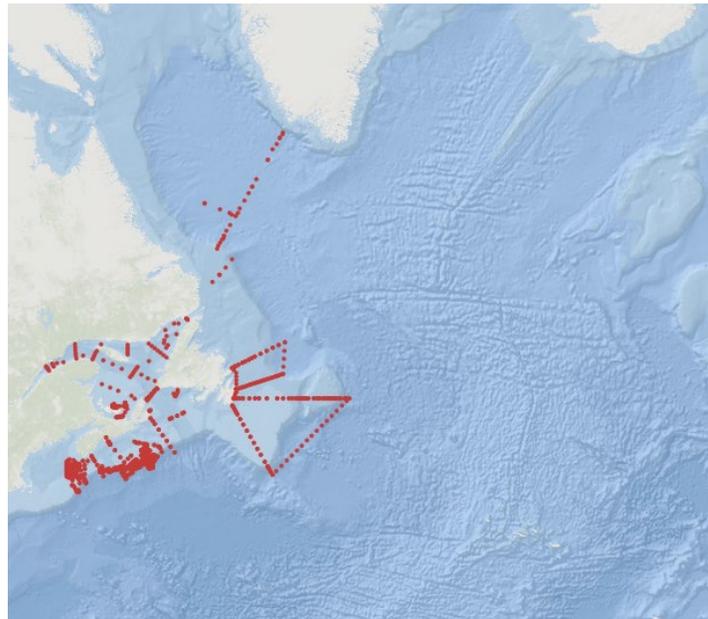
Immediately after, *Hudson* was used to conduct the fall sampling of the Atlantic Zone Monitoring Program (AZMP) transects across the Grand Banks for the Newfoundland

and Labrador Region (Eugene Colbourne, NAFC) (Cruise 2000-060). The usual variables were measured with a CTD Rosette and plankton nets. An Acoustic Doppler Current Profiler (ADCP) was run and expendable bathythermographs (XBTs) were deployed while in transit between stations. During the cruise, two short port calls were made into St. John's, NL.

This was followed by a physical oceanographic cruise to the Scotian Shelf and St. Pierre Bank (Gary Bugden, BIO) (Cruise 2000-066). The objectives included obtaining temperature and salinity profiles and nutrient and oxygen samples along the St. Pierre Bank and Halifax lines in support of climate and fisheries research, recovering current meter moorings and guard buoys on St. Pierre Bank, servicing a mooring at the edge of the Scotian Shelf and deploying two smaller instrumented moorings nearby, recover Sea Horse and an Acoustic Doppler Current Profiler (ADCP) mooring along the Halifax Line, acquire Acoustic Doppler Current Profiler (ADCP) profiles across various straits and banks while the ship was underway and familiarize staff with the operation of the Moving Vessel Profiler (MVP) fitted with CTD sensors. Standard equipment was used.

The final cruise of the year was back into the Gulf of St. Lawrence (Alain Gagné, IML) (Cruise 2000-068). This was the annual ice forecasting cruise and the standard grid of CTD stations was sampled throughout the Gulf and Estuary. Meteorological data were also collected. In addition, the standard transects were sampled for the measurement of chlorophyll, nutrients, oxygen, phytoplankton and zooplankton as part of the Quebec Region Atlantic Zone Monitoring Program (AZMP).

Upon return to BIO, *Hudson* began the second phase of her life extension refit.



Available cruise stations/tracks for 2000

2001

Over the winter, *Hudson* completed the second phase of an extensive refit to prolong her working life for another seven to ten years.

Cruises

Captains: Michel Champagne/Richard Smith

Number of Cruises: 10

Days at Sea: 180

Nautical Miles Steamed (Estimated): 28,620

The first cruise of the year was to the Scotian Shelf which was broken up into two legs with a personnel change at BIO partway through (Erica Head/ Michel Mitchell, BIO) (Cruise 2001-009). The main objective was to conduct the spring surveys along the standard Browns Bank, Roseway Bank, Halifax, Western Bank, Sable Island Bank, Louisbourg, Cabot Strait and Laurentian Channel lines of the now well-established Atlantic Zone Monitoring Program (AZMP). The standard variables were measured using a CTD Rosette and plankton nets. In addition, Acoustic Doppler Current Profiler (ADCP) and multi-frequency measurements were made, the Sea Horse and Acoustic Doppler Current Profiler (ADCP) moorings were recovered, equipment tests were performed with the Moving Vessel Profiler (MVP), vertical opening/closing nets and Batfish and engineering trials were carried out with an acoustic calibration system.

This was followed by a cruise to the Scotian Shelf and Labrador Sea which also involved scientists from Dalhousie University (Allyn Clarke, BIO) (Cruise 2001-022). There were numerous objectives. The first was to support the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The standard CTD transect, Line AR7W, across the Labrador Sea was sampled and this was the first time that XBTs were used, a practice which continued for many years. Two Labrador Sea current meter moorings were recovered to provide a measure of the winter cooling and water mass transformations over the winter of 2000/01. One mooring was reset on the Labrador slope to continue the 20+year observation program of the Labrador Current. A second objective was to continue the Labrador Sea Joint Global Ocean Flux Study (JGOFS) program, initiated in 1994, which was designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions. The biological component measured primary productivity, microbial processes, zooplankton, total organic carbon and sedimentation of organic matter. The physical/chemical component measured nutrients, total carbonate, alkalinity and CFCs over the entire water column in order to document the vertical flux of carbon via winter convection as well as changes in carbon storage in the deep waters of the North Atlantic. A third objective was to observe physical and chemical variables at various stations along the Halifax Line in support of the Atlantic Zone Monitoring Program (AZMP). A fourth objective was to recover and reset current meter moorings on the continental slope at the end of the Halifax Line designed to provide information on the structure of the current field related to the

initiation of exploration by industry for potential oil and gas fields on the continental slope. In addition, the Moving Vessel Profiler (MVP) was deployed on an opportunity basis while *Hudson* was transiting between BIO and the Labrador Sea to provide detailed estimates of the spatial structure of water masses of the Scotian Shelf, Cabot Strait and Gulf of St. Lawrence. No major problems were encountered and all objectives were achieved.

Next was a geophysical cruise to the Scotia Shelf which included two scientists from the Danish Lithosphere Centre and numerous participants from Dalhousie University (Ruth Jackson, BIO) (Cruise 2001-028). The goal of the program was to address questions concerning the evolution of the continental margin and sedimentary basins off Nova Scotia. Interpretation of the sedimentary and crustal structure was done along three seismic refraction lines perpendicular to the coastline to determine the velocity-depth structure to a depth of 40 km. Each line was traversed three times. On the first run, 21 Ocean Bottom Seismometers (OBSs) were deployed, on the second run the airgun array was fired while on the third run the OBSs were recovered. The current focus on seismic studies of margins by the international community pointed to increasing recognition of the scientific and socio-economic importance of understanding continental margins and their development. Greater understanding of and quantification of sedimentary basins and their basements will have important implications for the resource and risk management, exploration strategy and regulatory decisions in a region undergoing expanding petroleum exploration.

This was followed by a geological cruise to the Grand Banks (Gary Sonnichsen, BIO) (Cruise 2001-038). This was broken into two legs with a port call to St. John's, NL half way through to exchange personnel and to mobilize a ROV. Onboard were collaborators from C-CORE and the Kansas Geological Survey. The objectives of the first leg were to carry out experimental deep-towed multi-channel seismic experiments to measure sediment velocity and structure in the upper 50 m of the seabed and to conduct more conventional seismic operations using an airgun, the Huntec DTS, sidescan sonar and Towcam. The objectives of the second leg were to use a ROV, sidescan sonar and Towcam to investigate iceberg scours of known age to determine the processes of their formation and degradation. In addition, further seismic operations were carried out. Work was concentrated at the Hibernia, Terra Nova, White Rose and Hebron oil discovery areas on the northeast Grand Banks. The cruise terminated in St. John's, NL.

This was followed by another geological cruise to the Grand Banks, Flemish Pass, St. Pierre Slope and the Scotian Shelf which included participants from Dalhousie, Saint Mary's, the University of New Brunswick and INRS (Institut national de la recherche scientifique) (David Piper, BIO) (Cruise 2001-043). The many and diverse objectives included conducting regional seismic surveys and collecting cores on the Grand Banks margin to assess near-seabed stability for offshore hydrocarbon development, conducting high-resolution seismic surveys and collecting cores for studies of late Quaternary climate change including changes in the strength of the Labrador Current, assessing sediment distribution and the effects of deep bottom currents in the area south of the Tail of the Banks and the hazards to deep water fibre-optic cables,

collecting high quality geotechnical samples from the area of the 1929 sediment failure, conducting a seismic survey of a proposed Ocean Drilling Program (ODP) drill site on the south side of Orphan Knoll, conducting further seismic surveys to understand the tectonic origin of the Fogo Seamounts and collecting box cores and bottom photographs for regional assessment of benthic habitat. At the completion of the program, *Hudson* returned to BIO.

Next was a geological cruise to the Scotian Shelf, Scotian Slope, the Gulf of Maine and Georges Bank which was divided into two legs with a personnel exchange in Shelburne, NS (Dave Mosher/Brian Todd, BIO) (Cruise 2001-048). The objectives of the first leg were to acquire high-resolution seismic reflection profile data and piston cores to understand the processes of continental slope construction and destruction. Detailed investigations of 'type' areas were conducted. These type areas were representative of different geological settings including canyons, debris flow regions, areas of escarpments and rotational failures and constructional (unfailed) slope settings. Sediment samples were collected for geotechnical assessment using a box corer. Areas sampled included the Gully, Dawson Canyon and Verrill Canyon. The objectives of the second leg were to collect geophysical and geological information in areas where multibeam sonar data had previously been collected by the GSCA, CHS and the Offshore Scallopers Mapping Group, specifically southern German Bank, the Northeast Channel and Georges Bank. These surveys were designed to provide ground truth information for ongoing benthic habitat studies in the Gulf of Maine. This information will also contribute to the understanding of the Quaternary evolution of the Gulf of Maine and the associated changes in sea level. In collaboration with the US, a portion of their area on Georges Bank was surveyed.

Next was a cruise to continue investigating benthic habitat issues on the continental shelf and slope off Nova Scotia (Don Gordon, BIO) (Cruise 2001-055). It was divided into two legs with a return to BIO partway through to exchange personnel and equipment. Organized jointly by DFO and NRCan, the major objectives were to continue studies on deep-water corals and initiate a new program for determining essential fish habitat for haddock on the Scotian Shelf. The later objective included comparing different acoustic and optical methods for characterizing seabed habitat and associated fish populations. The fish habitat work involved collaboration with *Needler* to collect fish by otter trawling. Additional observations were made in support of ongoing programs including the impacts of hydraulic clam dredges on benthic habitat and communities, the Gully ecosystem, general benthic habitat mapping and deep-water sponges. Operations were carried out at Country Harbour, the Patch, Banquereau, Sable Island Bank, Western Bank, Emerald Bank, the Gully, the Scotian Slope, Northeast Channel, Georges Bank, Browns Bank and the Swissair crash site. Primary gear used was Campod, Videograb, CTD, QTC/Biosonics (with the new boom), Towcam and sidescan sonar. Non-BIO collaborators included the Northwest Atlantic Fisheries Centre, Institut Maurice-Lamontagne (IML), Dalhousie University, Memorial University and the National Research Council. There were also participants from the CBC, Habitat Management and the Biodiversity Science Branch in Ottawa. Highlights included collecting for the first time live specimens of deep-water corals with Videograb in the Northeast Channel which

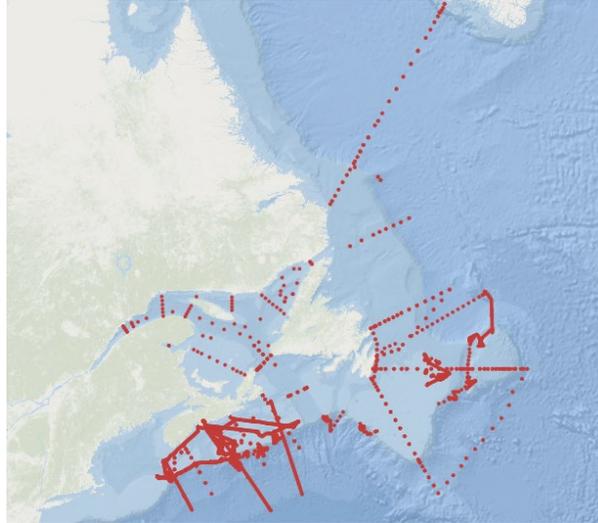
were successfully returned to BIO for lab studies. Weather was excellent and all objectives were achieved.

The next cruise was to the Scotian Shelf, Cabot Strait and Laurentian Channel which was broken into two legs with a personnel exchange partway thorough at BIO (Michel Mitchell/Ed Horne, BIO) (Cruise 2001-061). The major purpose was to carry out the standard fall sampling in the Maritimes Region for the Atlantic Zone Monitoring Program (AZMP). Other objectives included making Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements, testing the Moving Vessel Profiler (MVP), vertical opening/closing nets and a laser optical particle counter and servicing several moorings on the Scotian Shelf near the end of the Halifax Line. One of these moorings was for testing Icyler, a new instrument under development.

This was followed by a cruise was to the Grand Banks, Flemish Cap and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2001-068). It departed from and returned to BIO but stopped at St. John's to pick up and drop off Newfoundland staff and equipment. The purpose was to carry out the standard fall sampling for the Atlantic Zone Monitoring Program (AZMP) in order to establish the autumn temporal and spatial distribution and abundance of plant pigments, nutrients, microzooplankton and mesozooplankton in relation to the physical environment. A CTD Rosette was used to measure temperature, salinity, oxygen and chlorophyll along the standard transects. In addition, zooplankton were collected by vertical plankton net tows and Acoustic Doppler Current Profiler (ADCP) data were collected while steaming along each transect.

The final cruise of the year was back into the Gulf of St. Lawrence (Alain Gagné, IML) (Cruise 2001-072). This was the annual ice forecasting cruise and the standard grid of CTD stations was sampled throughout the Gulf and Estuary. Meteorological data were also collected. In addition, numerous standard transects were sampled for the measurement of chlorophyll, nutrients, oxygen, phytoplankton and zooplankton as part of the Atlantic Zone Monitoring Program (AZMP). Whale observations were also made.

Upon return to BIO, *Hudson* was laid up for the winter season.



Available cruise stations/tracks for 2001

2002

The Species at Risk Act received Royal Assent and became an important foundation for the conservation and protection of Canada's biodiversity. Using an offshore floating platform, oil production started at Terra Nova on the Grand Banks.

This year marked the 40th anniversary of BIO and *Hudson* was on display at a well-attended open house. Capt. Richard Smith wrote an article on historic firsts for *Hudson* which was published in the BIO Annual Review. Capt. Rick Ashton published *In Awe of a Wanderlust*, a book of yarns and poems based upon his life at sea.

During the winter, the final phase of the extensive refit to prolong *Hudson's* working life for another seven to ten years was completed. Delays caused the cancellation of the first cruise for the AZMP program scheduled in April.

In August of this year, OSD staff were involved in the deployment and recovery of oceanographic instrumentation in Barrow Strait using the *Pierre Radisson* and plans called for disembarking at Resolute, NWT. The team was weather-bound in Resolute for a few days and, remembering the Hudson 70 plaque that had been installed nearby at Cape Marty, they contacted Paul Amagoalik, a local resident, who knew the approximate location. After two hours of searching in the fog and cold, the plaque was found. Except for a few bullet holes, it was in remarkably good condition, a fitting tribute to the craftsmanship of Joe Avery, the *Hudson* bos'n on Hudson 70.

Based on research carried out onboard *Hudson*, a 424 km² coral conservation area was established by DFO in the Northeast Channel.

Cruises

Captains: Mike Hemeon/Rick Ashton

Number of Cruises: 10

Days at Sea: 154

Nautical Miles Steamed (Estimated): 24,486

The first cruise, which involved participants from BIO and the UK Southampton Oceanographic Centre, was to the Grand Banks and Flemish Cap for geophysical studies (Keith Loudon, DAL) (Cruise 2002-011). The main objectives were to deploy 21 OBSs and shoot airguns along a 400 km profile across the margin of Flemish Cap to determine crustal structure and conduct heat flow measurements to determine thermal structure. A secondary objective was to deploy 21 OBSs and shoot airguns in a detailed grid over the White Rose oil field to determine sediment structure. Near the conclusion of the cruise, the starboard stern tube developed a significant leak which forced *Hudson* to return to BIO prematurely for an emergency dry-docking.

This was followed by another geological cruise to German Bank, Georges Banks and the Gulf of Maine (Brian Todd, BIO) (Cruise 2002-026). The objectives were to collect additional geophysical and geological information in areas where multibeam sonar data had previously been collected by the GSCA, CHS and the Offshore Scallopers Mapping Group, specifically German Bank, the Northeast Channel and Georges Bank. As before, the surveys were designed to provide ground-truth information for ongoing benthic habitat studies in the Gulf of Maine. This information contributed to the understanding of the Quaternary evolution of the Gulf of Maine and the associated changes in sea level. In collaboration with the US, a portion of their area on Georges Bank was surveyed.

This was followed by a multidisciplinary cruise to the Scotian Shelf, Grand Banks and Labrador Sea which also involved scientists from the University of Quebec at Montreal (UQAM) (Allyn Clarke, BIO) (Cruise 2002-032). The first objective was to support the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The standard CTD transect across the Labrador Sea, Line AR7W, was sampled plus two Labrador Sea current meter moorings were recovered to provide a measure of the winter cooling and water mass transformations over the winter of 2001/02. One mooring was reset on the Labrador slope to continue the 21+year observation program of the Labrador Current. A second objective was to continue the Labrador Sea Joint Global Ocean Flux Study (JGOFS) which was designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions. Of particular note this year was the mooring of two sediment traps in the Labrador Sea to measure vertical particle flux over the next year. The biological component measured primary productivity, microbial processes, zooplankton, total organic carbon and sedimentation of organic matter. The physical/chemical component measured nutrients, total carbonate, alkalinity and CFCs over the entire water column in order to document the vertical flux of carbon via winter convection as well as changes in carbon storage in the deep waters of the North Atlantic. A third objective was to observe physical and chemical variables at various stations along the Halifax Line in support of the Atlantic

Zone Monitoring Program (AZMP). A fourth objective was to recover and reset current meter moorings on the continental slope at the end of the Halifax Line and in Flemish Pass to provide information on the structure of the current field to provide information required by industry in support of exploring for potential oil and gas fields on the continental slope. No major problems were encountered and all objectives were achieved. At the conclusion of this cruise, *Hudson* had been scheduled for a lengthy mid-season maintenance period. However, this was shortened considerably to allow a cruise that had to be cancelled on short notice in May for geohazard and pipeline route surveys on the Scotian Shelf to be done in collaboration with the Atlantic Canada Petroleum Institute (ACPI).

Next was a geological cruise to the Scotian Shelf (Bob Miller, BIO) (Cruise 2002-021). The general objectives were to further understanding of the morphodynamics of sand ridges on Sable Island Bank, to improve knowledge of bank-wide sediment dynamics, seabed stability and geohazard issues and to better understand the geological/stratigraphic framework and regional glacial reconstruction of Sable Island Bank. Bottom photographs, van Veen and IKU grab samples and sidescan sonar/seismic data were collected along various transects over sand ridges to understand the distribution and variation of surficial sediment grain size, small scale bedforms, vertical profiles and shallow sedimentary structures across these sand ridges. Seabed photos, van Veen and IKU grab samples and sidescan/seismic data were also obtained at selected sites displaying various types of bedforms and geohazards on Sable Island Bank to improve our knowledge on bank-wide seabed stability and geohazard issues. Seabed photos, bottom samples and sidescan sonar/seismic data were also collected at a site on the outer shelf for a future deployment of the instrumented seabed lander RALPH. Seismic surveys were conducted to tie new boreholes together. Seismic and sidescan data were also collected on the outer shelf and upper slope to better understand seabed stability and stratigraphy of these deep-water areas. Regional seismic surveys were also obtained in Brandal Basin and the upper Gully.

This was followed by a geological cruise to the Scotian Shelf, Scotian Slope, Laurentian Fan and Grand Banks (David Piper, BIO) (Cruise 2002-046). Scientists from Dalhousie, MIT and the US Geological Survey participated. The objectives were to obtain data on geohazards, geotechnical properties and shallow stratigraphy in selected areas of the Scotian Slope, detect the presence and distribution of gas hydrates on the Scotian Slope, investigate salt tectonics south of the St. Pierre slope and on top of the Wyandot surface in the central Scotian Shelf, deploy RALPH and investigate the seabed on the upper slope to understand the impact of internal waves on sediment transport, carry out an Ocean Drilling Program (ODP) site survey and obtain long cores of Holocene sediments. Equipment used included Huntec DTS, airgun, OBSs, sidescan sonar, large piston corer, RALPH and IKU grab.

This was followed by the annual benthic habitat cruise to the Scotian Shelf and Laurentian Channel (Don Gordon, BIO) (Cruise 2002-054). It was divided into three legs with returns to BIO to exchange personnel and equipment. Organized jointly by DFO, NRCan and the Northwest Atlantic Fisheries Centre (NAFC), the major objectives

were to continue studies of deep-water corals and essential fish habitat for haddock on the Scotian Shelf plus further studies on the fate and effects of wastes from hydrocarbon drilling. The work included conducting video surveys with Campod for deep-water corals in the Laurentian Channel, off the Stone Fence and the southern edge of the Grand Banks, collecting deep-water corals with Videograb at various locations, collecting sediment samples around the Venture and Thebaud platforms on Sable Island Bank and conducting benthic habitat and demersal fish surveys on Sable Island, Western and Emerald banks. Several days were lost at the start of the cruise when Hurricane Gustav passed through the region and *Hudson* sought shelter in La Poille Bay on the south coast of Newfoundland. Primary gear used was Campod, Videograb, IKU, CTD, QTC/Biosonics, Towcam, sidescan sonar, Slow Corer and BOSS. Non-BIO collaborators included the Northwest Atlantic Fisheries Centre, Memorial University, Dalhousie University, Acadia University and the University of Seville. There were also participants from the Marine Environmental Data Service (MEDS) and the Biodiversity Science Branch in Ottawa plus Habitat Management. The cruise was most successful with practically all objectives obtained. Immediately on return to BIO, *Hudson* quickly loaded mooring gear and steamed out to the approaches to Halifax Harbour to deploy it (Blair Greenan, BIO).

This was followed by a cruise to the Cabot Strait, Laurentian Channel and Scotian Shelf for the fall sampling of the Atlantic Zone Monitoring Program (AZMP) which was divided into two legs with a return to BIO for personnel exchange (Michel Mitchell/ Ed Horne, BIO) (Cruise 2002-064). Other objectives included making Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements, equipment tests on the Moving Vessel Profiler (MVP), vertical opening/closing nets and a laser optical particle counter, conducting Moving Vessel Profiler (MVP) surveys along the Atlantic Zone Monitoring Program (AZMP) lines, servicing Seahorse moorings and turning around two moorings at the shelf edge of the Halifax Line.

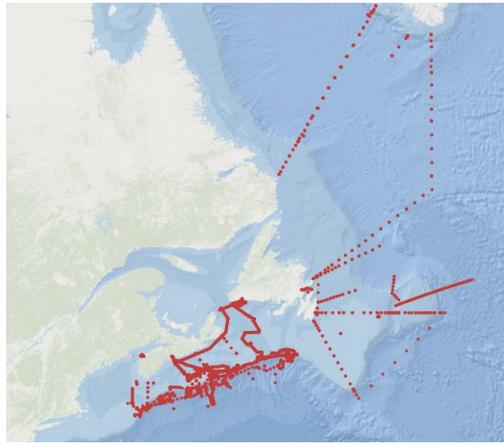
Next was a cruise to the Grand Banks, Flemish Pass and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2002-070). The purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. In addition, an Acoustic Doppler Current Profiler (ADCP) was run and expendable bathythermographs (XBTs) were deployed while in transit between stations. During the cruise, two short port calls were made into St. John's to exchange personnel and equipment. The cruise terminated in St. John's, NL.

This was followed by a short cruise to the Grand Banks and Flemish Pass (Murray Scotney, BIO) (Cruise 2002-073). The purpose was to recover and redeploy moorings in the Flemish Pass and complete a CTD survey on the Grand Banks near oil developments. At the conclusion of the program, *Hudson* returned to St. John's, NL.

The final cruise of the year was to the Labrador Sea which included participants from Dalhousie, University of Washington and Plymouth Marine Laboratory (Erica Head,

BIO) (Cruise 2002-075). The main objective was to determine the overwintering vertical depth distribution of the copepod *Calanus finmarchicus* along the AR7W section across the Labrador Sea. This was part of the international Global Ocean Ecosystem Dynamics (GLOBEC) project studying how this important species of zooplankton in the North Atlantic might be affected by global warming. Secondary biological objectives were to measure a series of standard physical, chemical and biological variables, measure primary and bacterial production plus microbial and zooplankton respiration and determine underwater light fields. A final objective was to deploy a current meter mooring in the Makkovik Basin. On the way back to BIO, *Hudson* encountered a severe storm on the Labrador Shelf and freezing spray resulted in an extensive build-up of ice on the decks overnight.

The season concluded in December when *Hudson* was docked at BIO for the winter.



Available cruise stations/tracks for 2002

2003

Cruises

Captains: Mike Hemeon/Rick Ashton

Number of Cruises: 12

Days at Sea: 198

Nautical Miles Steamed (Estimated): 31,482

The first cruise of the year was to the Scotian Shelf and Slope (Erica Head, BIO) (Cruise 2003-005) to conduct the spring sampling for the Atlantic Zone Monitoring Program (AZMP). Other objectives included deploying a mooring for the Canadian Surface Ocean Lower Atmosphere Study (SOLAS) and servicing several moorings along the Halifax Line. Unfortunately, refit delays caused this cruise to be shortened and the spring sampling for NORWATE, an international research program studying the distribution of zooplankton, had to be deferred until next year.

Next was a cruise to various locations in the northwest Atlantic (William Miller, DAL) (Cruise 2003-010). Beside Dalhousie, participants included the Institut Maurice-Lamontagne (IML), Laval, University of Quebec at Rimouski, Memorial and University of Calgary. The purpose was to carry out a joint DFO/university program called Surface Ocean Lower Atmosphere Study (SOLAS). The main objective of this program was to improve our understanding of the time variant changes of climatically active gas fluxes in the northwest Atlantic in order to further develop and validate existing carbon and sulphur models. This included determining the impact of the spring bloom on gas exchanges, especially that of sulphur. Both surface water and the atmosphere were sampled. During this 25-day voyage, *Hudson* first sailed from Halifax to the Sargasso Sea where repetitive sampling was done for twelve days in the same water mass marked by an Argo float and drogue. She then proceeded north to the southern tip of Greenland and sampled a transect across the Labrador Sea.

Next was a cruise to the Cabot Strait and Scotian Shelf (Michel Mitchell, BIO) (Cruise 2003-021). The main purpose to repeat the standard sampling along three lines of the Atlantic Zone Monitoring Program (AZMP). Other objectives included conducting Moving Vessel Profiler (MVP) surveys along the transects, making Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements, carrying out equipment tests on the Moving Vessel Profiler (MVP) and the laser optical particle counter and servicing three moorings at the shelf edge of the Halifax Line.

This was followed by a cruise to the Scotian Shelf and Laurentian Channel (Vladimir Kostylev, BIO) (Cruise 2003-029). The first objective was to collect piston cores in St. Margaret's Bay. The second was to collect bottom photographs throughout the eastern Scotian Shelf and Laurentian Basin to provide an inventory of bottom dwelling species as part of the recently established Eastern Scotian Shelf Integrated Management (ESSIM) initiative. The third objective was to collect seismic and sidescan sonar data to map seafloor stability and geological history in support of the Geoscience for Ocean Management initiative. Equipment used included Hunttec DTS, airgun, a new digital camera under development, piston corer, IKU grab and van Veen grab.

Next was a cruise to the Scotian Shelf, Scotian Slope, Laurentian Fan, Grand Banks and Orphan Basin which included scientists from the University of Quebec at Montreal and University of Pireas in Greece (David Piper, BIO) (Cruise 2003-033). This cruise addressed a number of issues concerning geohazards off the eastern coast, specifically foundation conditions and hazards in the Laurentian Basin, scour frequency estimates of the Grand Banks, geological risk factors on the Scotian Shelf and geological framework and hazard assessment on the slope of the northern Grand Banks. Specific objectives were seismic trials with new seismic equipment, investigation by seismic and cores of major failures on the slope, regional seismic profiles and cores in the Laurentian Channel and on the Scotian Shelf, repetitive sidescan surveys of iceberg scours on the Grand Banks, regional geohazard assessment by coring and seismic surveys in Orphan Basin, sampling for geochemical analysis of transport by the Labrador Current and acquisition of core-top dinoflagellate samples. Equipment used included Hunttec DTS, airgun,

sidescan sonar, Stacor and box corer. Partway through a short port call was made in St. John's, NL to transfer personnel.

This was followed by a multidisciplinary cruise to the Scotian Shelf, Grand Banks and Labrador Sea which involved participation of the Woods Hole Oceanographic Institution (WHOI) (Allyn Clarke, BIO) (Cruise 2003-038). This cruise was in support of five ongoing scientific initiatives. The first was to support the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The standard CTD transect across the Labrador Sea, Line AR7W, was sampled plus two Labrador Sea current meter moorings were recovered to provide a measure of the winter cooling and water mass transformations over the winter of 2002/03. One mooring was reset on the Labrador slope to continue the 22-year observation program of the Labrador Current. A second objective was to continue the Labrador Sea Joint Global Ocean Flux Study (JGOFS) program which was designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions. Of particular note this year was the recovery of the two sediment trap moorings deployed last year to measure vertical particle flux. The biological component measured primary productivity, microbial processes, zooplankton, total organic carbon and sedimentation of organic matter. The physical/chemical component measured nutrients, total carbonate, alkalinity and CFCs over the entire water column in order to document the vertical flux of carbon via winter convection as well as changes in carbon storage in the deep waters of the North Atlantic. A third objective was to observe physical and chemical variables at various stations along the Halifax Line in support of Atlantic Zone Monitoring Program (AZMP). A fourth objective was to recover and reset current meter moorings on the continental slope at the end of the Halifax Section, at the mouth of the Laurentian Channel and in Flemish Pass to provide information on the structure of the current fields related to the initiation of exploration by industry for potential oil and gas fields on the continental slope. In addition, two moorings were recovered on Makkovik Bank on the Labrador Shelf which had been set to measure sea ice drift and a complex sediment trap mooring was recovered off the mouth of the Laurentian Channel which had been deployed in April as part of the SOLAS program. No major problems were encountered and all objectives were achieved.

This was followed by a geological cruise up north to Davis Strait to carry out a joint NRCan/university study of deep crustal refraction using seismics (Ruth Jackson, BIO) (Cruise 2003-047).

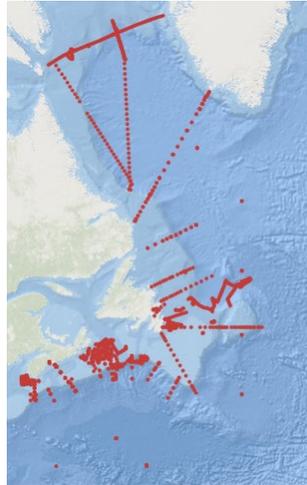
Next was a geological cruise to the western Scotian Shelf (Brian Todd, BIO) (Cruise 2003-054). The objectives were to collect additional geophysical and geological information in areas where multibeam sonar data had previously been collected off southwest Nova Scotia by CHS in support of a new scallop fishery opened in 2002 by DFO. Equipment used included Huntec DTS, airgun, sidescan sonar, Campod, IKU grab and box corer. This information contributed to the understanding of the benthic habitat and geological setting on the shelf off southwestern Nova Scotia.

Next was a cruise to continue investigating numerous benthic habitat issues on the Scotian Shelf which was divided into two legs with a return to BIO partway through to exchange personnel and equipment (Don Gordon/Dave McKeown, BIO) (Cruise 2003-059). As before, it was organized jointly by DFO, GSCA and the Northwest Atlantic Fisheries Centre (NAFC). The major objectives were to continue studies of deep-water corals and essential fish habitat for haddock on the Scotian Shelf plus further studies on the fate and effects of wastes from hydrocarbon drilling. Work included conducting video and photographic surveys with Campod for deep-water corals at the Stone Fence, collecting sediment samples around the Thebaud, Alma and Panuke platforms on Sable Island Bank and conducting benthic habitat and demersal fish surveys on Sable Island, Western and Emerald banks. Primary gear used included Campod, Videograb, QTC/Biosonics, Towcam, sidescan sonar, Slow Corer, BOB and INSSECT. Non-BIO collaborators included the Northwest Atlantic Fisheries Centre, Memorial University, Dalhousie University, Acadia University and Mount Saint Vincent University. DFO Staff from Habitat Management and Ottawa also participated plus journalists Rob North (CBC) and Jodi Delong (freelance). Numerous stories were filed in the media which helped raise the profile of *Hudson* and marine research at BIO with the Canadian public. High points included observing the first ever reported deep-water coral *Lophelia* reef in Canadian waters at the Stone Fence while Hurricane Juan was passing through the region and pounding Halifax. In addition, dense populations of glass sponges were discovered on the way home in The Patch.

Next was a cruise to the Cabot Strait, Laurentian Channel and Scotian Shelf which was broken up into two legs (Michel Mitchell/Ed Horne, BIO) (Cruise 2003-072). The main purpose was to repeat the standard sampling for Atlantic Zone Monitoring Program (AZMP). Acoustic Doppler Current Profile (ADCP) and multi-frequency sonar measurements were also made.

This was immediately followed by a cruise to the Grand Banks, Flemish Pass and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2003-075). Participants from the Woods Hole Oceanographic Institution (WHOI) and University of Washington were involved. The purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. In addition, an Acoustic Doppler Current Profiler (ADCP) was run and expendable bathythermographs (XBTs) were deployed while in transit between stations. Also, a mooring was deployed on the Grand Banks and thirteen APEX and RAFOS floats were deployed. During the cruise, two short port calls were made into St. John's, NL to exchange personnel and equipment and the cruise terminated there as well.

Departing from St. John's, the final cruise of the year was to the Grand Banks, Laurentian Fan and Scotian Shelf (Erica Head, BIO) (Cruise 2003-078). The main purpose was to collect the winter dataset of the international NORWATE program. Equipment used included a CTD Rosette, ring nets, the multinet system and an Acoustic Doppler Current Profiler (ADCP). The cruise terminated at BIO.



Available cruise stations/tracks for 2003

2004

The Gully was declared a 2,364 km² Marine Protected Area (MPA), the first in Atlantic Canada. In addition, a 15 km² coral conservation area was established at the Stone Fence to protect the recently discovered *Lophelia* reef. These management decisions by DFO were based on research carried out onboard *Hudson*.

Cruises

Captains: Dave Martin/Marc Rothwell/Mark Hemeon

Number of Cruises: 11

Days at Sea: 158

Nautical Miles Steamed (Estimated): 25,122

The first cruise of the year was a short trip out to the Scotian Slope to recover moorings (Murray Scotney, BIO) (Cruise 2004-005). In addition, a CTD survey was conducted, Acoustic Doppler Current Profiler (ADCP) measurements made and Seahorse and Acoustic Doppler Current Profiler (ADCP) moorings were deployed along a portion of the Halifax Line.

Next was a multipurpose cruise to the Scotian Shelf, Cabot Strait, St. Pierre Bank and the Grand Banks which was broken up into two legs (Ed Horne, BIO) (Cruise 2004-009). The main purpose was to carry out the spring sampling for Atlantic Zone Monitoring Program (AZMP) and the NORWATE program (which had been deferred from last year). In addition, Moving Vessel Profiler (MVP) surveys were run along the AZMP lines, the Seahorse mooring on the Halifax Line was recovered, a wave rider buoy was deployed off Lunenburg, Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements were made and equipment tests were performed on the Moving

Vessel Profiler (MVP), laser optical particle counter, portable Brooke Ocean Technology winch and a flow-through sampling system.

This was followed by a multidisciplinary cruise to the Scotian Shelf, Grand Banks and the Labrador Sea (Glen Harrison, BIO) (Cruise 2004-016). Participants from the UK Plymouth Marine Laboratory were on board. This cruise was in support of four ongoing scientific initiatives. The first was the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The standard CTD transect across the Labrador Sea, Line AR7W, was sampled plus one Labrador Sea current meter mooring was recovered to provide a measure of the winter cooling and water mass transformations over the winter of 2003/04. One mooring was reset on the Labrador slope to continue the 23-year observation program of the Labrador Current. A second objective was to continue the Labrador Sea Joint Global Ocean Flux Study (JGOFS) program which was designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions. Of particular note this year was the recovery of two sediment trap moorings deployed last year to measure vertical particle flux. The biological component measured primary productivity, microbial processes, zooplankton, total organic carbon and sedimentation of organic matter. The physical/chemical component measured nutrients, total carbonate, alkalinity and CFCs over the entire water column in order to document the vertical flux of carbon via winter convection as well as changes in carbon storage in the deep waters of the North Atlantic. A third objective was to observe physical and chemical variables along the Halifax Line in support of the Atlantic Zone Monitoring Program (AZMP). A fourth objective was to deploy profiling floats as a Canadian contribution to the international Argo program. Seven floats were deployed in the Labrador Sea and three at Orphan Knoll. In addition, a member of the Whale Release and Strandings Group was on board to identify northern bottlenose whales. The cruise was hampered by heavy ice conditions off Labrador, bad weather and a medical emergency so that the objectives were not fully achieved. It terminated in St. John's, NL.

This was followed by a cruise to the Orphan Basin, Flemish Pass, Laurentian Fan and Scotian Shelf which also involved participants from Dalhousie and the Plymouth Marine Laboratory (Igor Yashayaev, BIO) (Cruise 2004-019). There were various objectives. Oceanographic sections were occupied across the Flemish Pass and Orphan Basin as contributions to a BIO/industry study of the environmental factors affecting oil and gas exploration, the DFO Ocean Climate Program, the Arctic-Subarctic Ocean Flux Study (ASOF) and the Climatic Variability and Predictability Project (CLIVAR). Physical, chemical and biological observations were made along a section across the Laurentian Channel and along the Halifax Line. Current meter moorings and guard buoys were recovered and reset in the Flemish Pass while five current meters were deployed in Orphan Basin. In addition, a current meter mooring and three guard buoys were recovered in the outer Laurentian Channel. At the completion of the program, *Hudson* returned to BIO.

Next was a geological cruise to St. Pierre Slope, Grand Banks, Flemish Pass and Orphan Knoll with participants from Memorial and the University of Quebec at Montreal

(UQAM) (David Piper, BIO) (Cruise 2004-024). This cruise was in support of the current program assessing geohazards off the east coast of Canada. General objectives were to carryout reconnaissance assessment of foundation conditions and hazards in the Laurentian sub-basin, measure iceberg scour frequency on the Grand Banks and study the geological framework and hazard assessment in the Flemish Pass and the slope of the Grand Banks. Equipment used included Hunttec DTS, airgun, sidescan sonar, box corer, dredge and bottom cameras. Specific objectives included studying mounds on Orphan Knoll, examining gas hydrates in Flemish Pass and seafloor geochemical studies. The cruise ended in St. John's, NL.

Following was another geological cruise to Laurentian Fan, Scotian Slope and Scotian Shelf (David Mosher, BIO) (Cruise 2004-030). This involved participants from Dalhousie, Saint Mary's and Acadia universities. The primary objective was to investigate gas hydrate deposits on the eastern continental slope. These constituted a potential fuel for the future. Secondary objectives included further assessment of geohazards and acquisition of geophysical data for the Eastern Scotian Shelf Integrated Management program (ESSIM). In addition, new geotechnical tools being developed for geohazard research were tested. Operations included conventional seismic reflection surveys using the Hunttec DTS, sidescan sonar surveys, heat flow measurements, piston and box coring and dredging. *Hudson* returned to BIO upon completion of operations.

Next was a cruise to Sable Island Bank as part of the nature and severity of geohazards studies of the GSCA Offshore Geohazard project (Michael Li, BIO) (Cruise 2004-037). The first purpose was to collect seabed photos and samples and conduct new and repeat geophysical surveys to better understand the nature, distribution and mobility or potential risk of bedforms and other geohazards on Sable Island Bank. The second purpose was to obtain vibracores and conduct geophysical surveys along selected tracks to further knowledge of the geological framework and shallow stratigraphic structures of Sable Island Bank. Equipment used included the Hunttec DTS, sidescan sonar, seismic, van Veen and IKU grab samplers, Vibracorer and a bottom camera. Seabed images, samples, cores and seismic/sidescan surveys were made at Cohasset-Panuke Project (Copan), South Sable, Venture as well as various sites and the proposed pipeline routes of the Sable Offshore Energy Project (SOEP).

This was followed by a cruise to the Gulf of St. Lawrence and Cabot Strait which was divided into two legs (B. Morin/D. Archambault, IML) (Cruise 2004-038).

Hudson was then scheduled for a six-week period of paint and preservation work in Quebec. However, delays in the painting caused the loss of a cruise to study the effects of production wastes around the Hibernia platform. Then, a Public Service labour strike resulted in the cancellation of the final cruise of the three-year fish habitat program on Emerald, Western, and Sable Island banks plus the loss of a portion of the fall Atlantic Zone Monitoring Program (AZMP) cruise for the Maritimes Region.

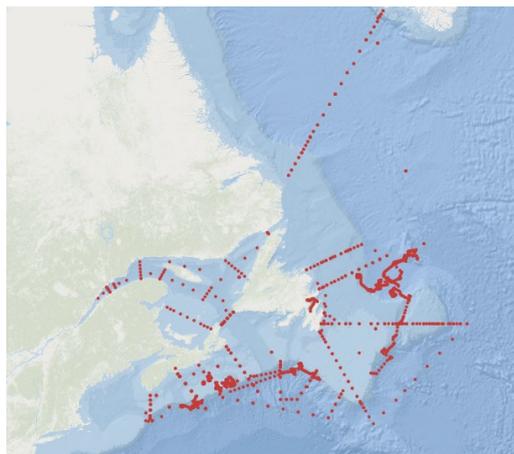
When the strike was settled, *Hudson* departed on a biological cruise to the Scotian Shelf, Scotian Slope and Cabot Strait with participants from Dalhousie University (Erica Head,

BIO) (Cruise 2004-055). The main purpose was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP). Other objectives included conducting krill surveys in the Gully, Roseway and Emerald basins, multinet zooplankton vertical tows and deployment of moorings in slope waters, deployment and recovery of a Seahorse mooring on the Halifax Line, Moving Vessel Profiler (MVP) transects on the Browns Bank and Halifax lines and recovery of an Acoustic Doppler Current Profiler (ADCP) tripod on Sable Island Bank.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary (Alain Gagné, IML) (Cruise 2004-061). The main objectives were to carry out the annual fall ice forecasting program and the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) for the Quebec Region. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, the biomass of zooplankton was evaluated using BIONESS and a current meter mooring was recovered in the Strait of Belle Isle.

This was immediately followed by a cruise to the Grand Banks, Flemish Pass and northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2004-065). This was broken into two legs with a crew change in St. John's, NL. It included participants from Memorial, Duke University and the Woods Hole Oceanographic Institution (WHOI). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. In addition, a mooring was recovered on the Grand Banks, a guard buoy was recovered and redeployed in Flemish Pass and twelve RAFOS profiling floats were deployed in support of the international Argo program. This deployment of the RAFOS floats marked the halfway point in the planned 3000 float program.

The season concluded in December and *Hudson* was docked at BIO for the winter.



Available cruise stations/tracks for 2004

2005

Using an offshore floating platform, oil production started at White Rose on the Grand Banks

Because *Hudson* was unavailable in April due to refit delays, *Needler* carried out the annual spring sampling for Atlantic Zone Monitoring Program (AZMP) for the Maritimes Region.

Cruises

Captains: Paul Bragg/Dave Martin/Richard Smith

Number of Cruises: 12

Days at Sea: 175

Nautical Miles Steamed (Estimated): 27,825

The first cruise of the year was to Flemish Pass and Orphan Basin (Igor Yashayaev, BIO) (Cruise 2005-012). Oceanographic sections were occupied across the Flemish Pass and Orphan Basin as contributions to the BIO/industry study of the environmental factors affecting oil and gas exploration, the DFO Ocean Climate Program, the Arctic-Subarctic Ocean Flux Study (ASOF) and the Climatic Variability and Predictability Project (CLIVAR). Two current meter moorings and four guard buoys were recovered in Flemish Pass, five current meter moorings were recovered in Orphan Basin and six new ones were deployed. An Acoustic Doppler Current Profiler (ADCP) was operated between stations throughout the cruise. The cruise terminated in St. John's, NL.

This was followed by a multidisciplinary cruise to the Scotian Shelf, Grand Banks and the Labrador Sea which included participants from Dalhousie and the University of New England (Glen Harrison, BIO) (Cruise 2005-016). As in previous cruises in this series, the cruise was in support of four ongoing scientific initiatives. The first was the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The occupation of the Labrador Sea transect, Line AR7W, again provided a measure of the winter cooling and water mass transformations over the winter of 2004/05. Resetting the mooring continued the 24-year observation program of the Labrador Current. A second objective was the continuation of the Labrador Sea Joint Global Ocean Flux Study (JGOFS) program which, initiated in 1994, has been concerned with natural and anthropogenic carbon cycles. The biological component was designed to characterize the late spring biological processes in the Labrador Sea and its shelf regions. The physical/chemical component measured nutrients, total carbonate, alkalinity and CFCs over the entire water column in order to document the vertical flux of carbon via winter convection as well as changes in carbon storage in the deep waters of the North Atlantic. A third objective was to observe physical and chemical variables along the Halifax Line in support of the Atlantic Zone Monitoring Program (AZMP). A fourth objective was to deploy two more profiling floats in the Labrador Sea as a Canadian contribution to the international Argo program. There were no major problems and all goals were achieved. *Hudson* returned to BIO a day ahead of schedule.

Hudson next departed for the Gulf of Maine to start a multi-year project studying biodiversity along the Discovery Corridor which extended from the coast at the New Brunswick/Maine international border through the Gulf of Maine and Northeast Channel out past the shelf break (Erica Head, BIO) (Cruise 2005-021). This was a collaborative effort between DFO, the Centre for Marine Biodiversity (based at BIO), Atlantic regional universities and the Atlantic Reference Centre in St. Andrews to increase understanding of the benthos in previously unexplored areas in the Gulf of Maine. Included were participants from the St. Andrews Biological Station, the Atlantic Reference Centre, Dalhousie, Acadia and the University of Maine. Also on board were a school teacher and a journalist from the CBC. Station locations and sampling tools were selected to maximize the probability of finding deep-water corals. Specific objectives included conducting hydrographic sampling and benthic habitat surveys in Jordan Basin, Crowell Basin and the Northeast Channel. In addition, sightings of migratory Right Whales were recorded and hydrographic data were collected on the Halifax Line. Primary equipment used included a CTD Rosette, Videograb, Campod and BIONESS.

Next was a geological cruise to the Northeast Channel and Scotian Slope in support of the ongoing GSCA Geohazard Program (Edward King, BIO) (Cruise 2005-023). The scientific objectives were to understand the magnitude and processes of deep-water tidal current-driven sand wave migration on both flanks of the outer Northeast Channel and the unique bedforms of the central channel floor, to assess the optimal placement of the seabed lander RALPH for deployment in 2006 and investigate the processes in the mega-current furrows on the southern channel flank. This was accomplished through seabed sampling, imaging and seismic/sidescan sonar surveys at selected types of bedforms. Further objectives were to investigate late Quaternary deposits on the continental slope off Browns Bank in order to better understand geohazards and geological history. Issues addressed included the extent and stratigraphic position of glacial till on the upper slope, the record of sediment discharge down the Northeast Channel, the ground truthing of previously acquired Huntec data and the acquisition of new seismic data to better understand sediment architecture.

This was followed by a cruise to the Grand Banks for studies of operational wastes routinely discharged from the Hibernia platform (Ken Lee, BIO) (Cruise 2005-028). Participants from the Northwest Atlantic Fisheries Centre (NAFC), Dalhousie, Queens and Concordia universities were involved. The scientific objectives were to sample water, seabed sediments and boundary layer suspended sediment for contaminants associated with production water discharges, sample water, seabed sediments and boundary layer suspended sediment for microbial biomass, community structure, activity and function, sample seabed sediments for barite derived from drilling mud discharge and conduct seabed video surveys for comparison with previous records. Equipment included CTD Rosette, Campod, slow corer, BOSS and a zooplankton net for vertical tows. Special permission was obtained from the Hibernia Development Management Corporation (HDMC) to enter the 500 m exclusion zone around the platform for sampling near the produced water discharge pipe and samples of fresh produced water were transferred to *Hudson* from the platform using the ship's Fast Rescue Craft (FRC).

Next was a geological cruise to the Scotian Shelf, Labrador Sea and Orphan Basin which was divided into two legs with a port call partway through into St. John's, NL to exchange personnel (Michael Li/Dave Mosher, BIO) (Cruise 2005-033). The first leg was for the Offshore Geohazard project of the Geoscience for Oceans Management (GOM) program of NRCan. The objectives were to conduct repeat sidescan surveys at selected study areas to assess the mobility of targeted bedforms over one winter season and to collect seabed video images and bottom samples at known morphological locations across bedform profiles to determine the surficial sediment grain size and its variation across various bedforms. Seabed sampling was done using Videograb. In addition, the instrumented seabed lander RALPH was deployed at the head of Logan Canyon and three OBSs were recovered from the Gully. The objectives of the second leg were principally focused on regional geohazard assessment in active or potential hydrocarbon exploration regions. Work focused on slope stability assessment, deep-water gas hydrate evaluation and shallow seabed geohazards such as ice scour on Makkovik Bank.

Next was a geophysical cruise to the Davis Strait (Keith Loudon, DAL) (Cruise 2005-040). The purpose was to collect heat flow measurement in sediment at six stations along and across the Strait using the Dalhousie heat flow probe. The stations were in distinct basins and plateaus to determine the regional variability in heat flow. The results were used to refine understanding of the regional tectonic framework and provided critical information for petroleum modelling programs. The cruise terminated in Nuuk, Greenland. This was *Hudson's* first foreign port visit for several years.

This was followed by a cruise to Davis Strait, Baffin Bay and Labrador Sea which involved a contingent of scientists from the University of Washington (Brian Petrie, BIO) (Cruise 2005-045). There were numerous objectives. Oceanographic sections were occupied across Davis Strait, southern Baffin Bay and northern Labrador Sea and CTD data and water samples for chemical analysis collected as a contribution to the Arctic sub-Arctic Ocean Flux (ASOF) program. Analyses included nutrients, trace metals, total inorganic carbon, total alkalinity, CFCs and iodine isotopes. Fifteen current meter moorings were recovered and redeployed in the Davis Strait. Three autonomous SeaGliders were launched from *Hudson* for the first time in Davis Strait to study the fresh water and ice fluxes coming out of the Arctic Ocean. In addition, six profiling drifting floats were deployed in the northern Labrador Sea in support of the Argo program. Acoustic Doppler Current Profiler (ADCP) measurements were made between stations throughout the entire cruise. Partway through, *Hudson* made a port call back into Nuuk, Greenland to transfer some staff ashore before the long steam back to BIO.

This was followed by a cruise in early October to the Scotian Shelf to complete the four-year fish benthic habitat program (John Anderson, NAFC) (Cruise 2005-048). Repeat surveys were conducted at the six previously selected study sites on Sable Island, Western and Emerald banks. Primary gear used included Campod, Videograb, QTC/Biosonics, Towcam and sidescan sonar. In addition, *Needler* sampled demersal fish populations at the study sites using an otter trawl. Non-BIO collaborators included the

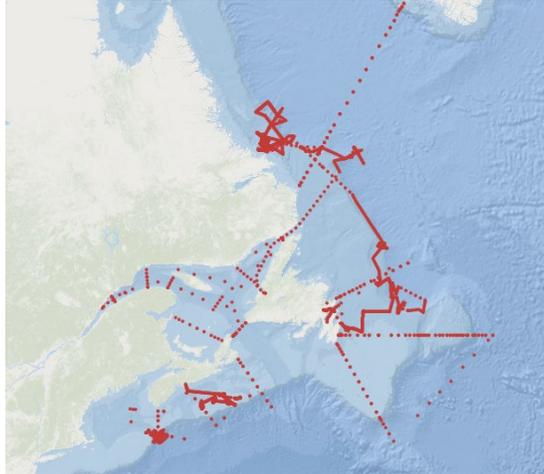
Northwest Atlantic Fisheries Centre, St. Andrews Biological Station, Memorial University and Dalhousie University. DFO staff from Ottawa also participated. In addition, Jodi DeLong came along for a second cruise and submitted numerous stories to the Halifax Chronicle Herald. Near the end of the cruise, an unsuccessful attempt was made to recover RALPH, the bottom-mounted system for measuring sediment stability and transport, from the head of Logan Canyon. Despite a delay in departure due to a sick crew member, most of the objectives were accomplished and the cruise was most successful. Immediately upon return, Capt. Smith organized a reception on board to celebrate the successful completion of this joint BIO and NAFC fish habitat program.

Next was a cruise to the Cabot Strait, Scotian Shelf and Northeast Channel (Erica Head, BIO) (Cruise 2005-055). The primary purpose was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) in the Maritimes Region. Other objectives were to sample stations in the Gulf of Maine and Northeast Channel with a view to expanding the AZMP, recover and redeploy moorings in slope waters and deploy three Argo profiling floats. Near the end of the cruise, *Hudson* returned to BIO for a crew change.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary (Alain Gagné, IML) (Cruise 2005-058). The main purpose was to carry out both the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) for the Quebec Region and the annual fall ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, the biomass of zooplankton was evaluated using BIONESS, three moorings were replaced in the Estuary and one mooring was replaced in the Strait of Belle Isle. During the cruise, three port calls were made to Rimouski, QC to exchange personnel.

The final cruise of the year was to the Grand Banks, Flemish Pass and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2005-062). During the cruise two port calls were made into St. John's, NL to exchange personnel. The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. In addition, Acoustic Doppler Current Profiler (ADCP) surveys were run along each Atlantic Zone Monitoring Program (AZMP) transect and twelve RAFOS profiling floats were deployed along the Bonavista Line in support of the international Argo program.

Hudson then returned to BIO in mid-December for the winter.



Available cruise stations/tracks for 2005

2006

Hudson started her program two weeks later this year than planned due to a crane overhaul and certification issues.

Cruises

Captains: Paul Bragg/Dave Martin/ Todd Gilmore/Gary Sanders

Number of Cruises: 14

Days at Sea: 197

Nautical Miles Steamed (Estimated): 31,323

The first cruise was to the Scotian Shelf which involved participants from the BIO Oceans and Habitat Management Branch (Blair Greenan, BIO) (Cruise 2006-006). The top priority was to deploy four moorings in the Gully to measure currents, temperature and salinity for one year. A survey of the Gully provided data on temperature, salinity, oxygen, nutrients, chlorophyll, bacteria and zooplankton. Sediment grabs were collected at six locations in the Gully for hydrocarbon contaminant analysis and a Moving Vessel Profiler (MVP) survey was conducted in the Gully to provide a synoptic view of the upper ocean hydrography. In addition, OBSs were deployed for engineering tests of design modifications and Halifax Station 2 was sampled as part of Atlantic Zone Monitoring Program (AZMP). Seabird observations were also carried out by the Canadian Wildlife Service (CWS) and marine mammal observations were made by a Dalhousie graduate student.

Next was the annual spring cruise to the Scotian Shelf for the Atlantic Zone Monitoring Program (AZMP) (Ed Horne, BIO) (Cruise 2006-008). Again, participants from the BIO Oceans and Habitat Management Branch were involved. It was broken up into three legs with port calls partway through into Sydney and Halifax to exchange personnel. The Cabot Strait, Louisbourg, Halifax and Browns Bank lines were sampled with CTD

Rosette, optical particle counter (OPC), nets and the Moving Vessel Profiler (MVP). In addition, four moorings were deployed in the Gully. A survey of the Gully provided data on temperature, salinity, nutrients, chlorophyll, bacteria and zooplankton. Sediment grabs were collected at six locations for hydrocarbon contaminant analysis and a Moving Vessel Profiler (MVP) CTD survey was conducted to provide a synoptic view of the upper ocean hydrography. In addition, ocean bottom seismometers (OBSs) were again deployed for engineering tests.

This was followed by a cruise to the Laurentian Fan and Orphan Basin (Igor Yashayaev, BIO) (Cruise 2006-011). Immediately after departing BIO, some mooring operations were conducted at Halifax Station 2 and when completed some staff were transferred ashore by Fast Rescue Craft (FRC) before *Hudson* steamed to the Laurentian Fan. The main purpose was to occupy oceanographic sections in the Laurentian Fan and Orphan Basin regions as a contribution to a joint DFO, PERD/industry study of the environmental factors affecting oil and gas exploration, to the DFO Ocean Climate Program, to the Arctic-Subarctic Ocean Flux study (ASOF) and to the Climate Variability and Predictability Project (CLIVAR). In addition, two current meter moorings were deployed in the Laurentian Fan region, six current meter moorings were recovered in Orphan Basin and six replacement current meter moorings were deployed. An Acoustic Doppler Current Profiler (ADCP) was operated between stations for the entire cruise which ended in St. John's, NL.

Next was a cruise to the Labrador Sea (Ross Hendry, BIO) (Cruise 2006-019). Also involved were participants from Dalhousie, McGill and Memorial universities plus the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). There were numerous objectives. Physical, chemical and biological measurements were carried out along the AR7W line and related sections in the Labrador Sea as part of the DFO ocean circulation and climate program. These measurements provided a measure of the winter cooling and water mass transformations over the 2005/06 winter. A current meter mooring was recovered and reset on the slope off Hamilton Bank to continue the long-term observation program of the Labrador Current. These measurements contributed to the monitoring activities of the Global Climate Observing System (GCOS) and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). In addition, a biological and chemical program was carried out in the Labrador Sea in support of the Joint Global Ocean Flux Study (JGOFS) and Canada's program on Enhancement of Greenhouse Gas. This included primary productivity, zooplankton and carbon system measurements. Six profiling drifting floats were deployed in the Labrador Sea in support of the international Argo program. And finally, physical, chemical and biological measurements were made along the Halifax Line in support of Atlantic Zone Monitoring Program (AZMP). Additional stations were added at the seaward end as a pilot version of a possible enhancement of this monitoring effort. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated between stations during the cruise. No major problems were encountered and all scientific goals were achieved. The absence of coastal ice this year allowed full occupation of the AR7W line across the Labrador Sea.

This was followed by a cruise to the Scotian Shelf and Grand Banks which involved participants from Memorial and Concordia universities (Ken Lee, BIO) (Cruise 2006-022). The primary objective was to continue various studies investigating the environmental impacts of operational wastes being discharged from the Hibernia platform on the Grand Banks. These included sampling water, seabed sediments and benthic boundary layer suspended sediment for inorganic and organic contaminants associated with produced water discharges, microbial biomass, community structure, activity and function, sampling seabed sediments for barite derived from drilling mud discharges and conducting seabed video surveys for comparison with previous records. Sampling within the 500 m exclusion zone around the platform was done using the Fast Rescue Craft (FRC). Samples of fresh produced water before discharge were transferred to *Hudson* by FRC. In addition, before heading to Hibernia, *Hudson* recovered a mooring on the Halifax Line and collected eight sediment cores in the Gully. Equipment used included CTD Rosette, Acoustic Doppler Current Profiler (ADCP), Campod, slow corer, BOSS and bongo nets.

Next was a cruise to the Gulf of Maine and Northeast Channel (Peter Lawton, SABS) (Cruise 2006-034). This was a collaborative effort with Dalhousie, Memorial, the Centre of Marine Biodiversity and the Atlantic Reference Centre to increase understanding of the benthos in previously unexplored areas in the Gulf of Maine with a focus on deep-water corals. Also on board were a school teacher and artist/film producer. All the stations were in the Discovery Corridor, an area chosen to focus marine biodiversity efforts in the region which was first sampled the year before. The primary sampling tool was the remotely operated vehicle (ROV) ROPOS (Remotely Operated Platform for Oceanographic Science) operated by the Canadian Scientific Submersible Facility (CSSF) based in Saanich, BC and seven of their engineering staff were on board. This was the first time that ROPOS, equipped with still and video cameras plus mechanical sampling arms, was used on *Hudson*. This required the temporary installation of a custom crane on the foredeck for deployment. ROPOS was capable of working down to depths of 2,500 m. The research team from Dalhousie deployed small trays at several locations on the seabed to act as multi-year settlement trays for deep-sea corals. In addition, the DFO research team used the precise positioning capabilities of ROPOS to collect small sections from deep-sea coral colonies located at different distances from each other. Six specific areas were surveyed: German/Browns Bank, Jordan Basin, Grand Manan Basin, Georges Basin, the Coral Conservation Area in the Northwest Channel and Corsair Canyon. Multi-corer operations were carried out when ROPOS was on deck for servicing. The cruise was most successful and produced many exciting results.

Next was a geological cruise to Placentia Bay (John Shaw, BIO) (Cruise 2006-039). Objectives were to ground-truth bottom sediments in preparation of producing sediment maps of Placentia Bay, date the glacier advance to the Burin Moraine, date the onset of megafault erosion and examining the effects of the 1929 tsunami. Equipment used included Hunttec DTS, airgun, sidescan sonar, Long Coring Facility, IKU grab, van Veen grab and bottom camera. On the way to Placentia Bay, OBSs were deployed in the Gully. The cruise terminated in St. John's, NL.

This was followed by a geological cruise to Orphan Knoll, the Labrador Sea and Hudson Strait (Calvin Campbell, BIO) (Cruise 2006-040). The overall objective was to carry out a regional geological assessment of offshore seabed conditions and geohazards to assist regulatory and policy decisions in advance of anticipated offshore oil and gas exploration and development. Equipment used included Hunttec DTS, airgun, sidescan sonar, Long Coring Facility, IKU grab, van Veen grab and bottom camera. On the way back to BIO, the OBSs deployed in the Gully on the previous cruise were recovered.

This was followed by a geological cruise to the Scotian Slope with numerous participants from Dalhousie (Dave Mosher, BIO) (Cruise 2006-046). The primary objective was to investigate gas hydrate reserves. The program included seismic reflection and refraction measurements using OBSs, heat flow measurements, piston coring and camera stations. In addition, several new geological sampling tools under development were tested. The cruise terminated in St. John's, NL.

Next was another geological cruise to the Grand Banks, Laurentian Channel and Scotian Slope with participants from Dalhousie, Memorial and Stanford universities (David Piper, BIO) (Cruise 2006-048). The overall purpose was to carry out regional studies of geohazards and possible constraints to offshore oil and gas development. Specific objectives included investigating upper slope processes and turbidity current initiation in Flemish Pass, collecting reconnaissance seismic and sidescan sonar data in the central Grand Banks for foundation studies, obtaining cores from shelf basins as a record of Holocene change in iceberg flux and to date glacial features, map Halibut Channel using seismic and sidescan sonar for foundation and pipeline route assessment, carry out geohazard assessment in the Laurentian Channel using the Hunttec DTS and seismic profiling, obtaining cores to assess seafloor stratigraphy and behaviour of turbidites and assessing the eastern Scotian Shelf for regional pipeline route assessment. At completion of the program, *Hudson* returned to BIO.

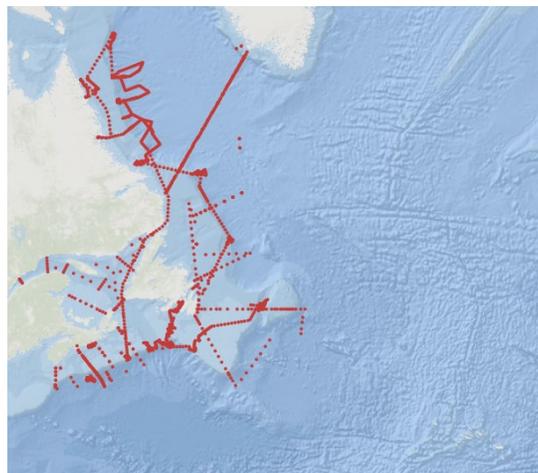
Next was a cruise to the Scotian Shelf and Cabot Strait (Erica Head, BIO) (Cruise 2006-052). This was divided into two legs with a personnel exchange partway through at BIO. The primary purpose was to carry out the annual fall sampling for Atlantic Zone Monitoring Program (AZMP) at four transects across the Scotian Shelf, in the Cabot Strait and the Gully. In addition, Moving Vessel Profiler (MVP) deployments were made along the Browns Bank and Halifax lines, extra stations were sampled in the Gully and off St. Pierre Bank, moorings for a joint Canadian/UK program were recovered and reset in slope water at the end of the Halifax Line and three Argo floats were deployed.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary (Alain Gagné, IML) (Cruise 2006-057). The main purpose was to carry out both the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, the biomass of zooplankton was evaluated using BIONESS, three moorings were replaced in the Estuary and one mooring was replaced in the Strait of Belle Isle.

Next was a cruise to the Grand Banks, Flemish Pass and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2006-061). Partway through a port call was made into St John's, NL for a crew change. The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. Expendable bathythermographs (XBTs) were deployed between stations while the ship was underway. In addition, twelve RAFOS profiling floats were deployed along the Bonavista Line in support of the international Argo program. Two oceanographic moorings were also deployed.

The final cruise of the year was to the Scotian Shelf which involved Dalhousie (Norman Cochrane, BIO) (Cruise 2006-063). The objectives were to carry out plankton net tows and CTD measurements at Station 2 on the Halifax Line as part of the Atlantic Zone Monitoring Program (AZMP), recover Ocean Bottom Seismometers (OBSs) and acoustic recorders in the Gully, conduct a CTD survey of the Gully and make marine mammal observations.

Upon return to BIO, Hudson was scheduled to recover moorings in the Gully but this short cruise had to be cancelled because of propulsion problems and the task was transferred to the *Sir William Alexander*.



Available cruise stations/tracks for 2006

2007

Replacement of the ageing Canadian scientific research fleet continued to be a high priority and the Government of Canada announced a new shipbuilding program which included a successor to *Hudson*. A start was made on developing a Statement of Requirements (SOR) for this new vessel which was expected to be completed in early 2008 and delivery of the new vessel was optimistically projected to be in 2013.

Hudson was on display at the BIO Open House in October.

This year marked the start of Atlantic Zone Off-Shelf Monitoring Program (AZOMP). This program, created by the Maritimes Region of DFO, was designed to extend the Atlantic Zone Monitoring Program (AZMP), underway since 1998, into deeper water offshore. It involved collecting physical, chemical and biological data in slope water in order to investigate the global climate system, variability in ocean climate, ecosystems off Atlantic Canada and plankton affecting regional climate. It was also designed to contribute to international ocean observation, climate and carbon programs such as the Global Ocean Observation System, Climate Variability and Prediction Project, International Ocean Carbon Coordination Project and the Global Ocean Ship-based Hydrographic Investigations Program. There were three major components. The Labrador Sea Monitoring Program was to be the largest component. It collected and analyzed physical, chemical and biological data on the AR7W Line across the Labrador Sea. The Scotian Slope and Rise Monitoring Program collected and analyzed physical, chemical and biological data along a seaward extension of the Halifax Line which had been regularly sampled as part of the Atlantic Zone Monitoring Program (AZMP). The third component was the international Argo Float Program which used robotic profiling floats to collect temperature and salinity data from the upper 2,000 m of the ocean and transmit the data ashore via satellite. This new long-term program required extensive ship time and *Hudson* was obviously the logical vessel to use for this multidisciplinary initiative.

Cruises

Captains: Gary Sanders/Paul Bragg/Todd Gilmore/Michel Champagne

Number of Cruises: 11

Days at Sea: 180

Nautical Miles Steamed (Estimated): 28,620

The first cruise of the year was the annual spring Atlantic Zone Monitoring Program (AZMP) cruise to the Scotian Shelf and Cabot Strait with participants from Dalhousie University (Ed Horne, BIO) (Cruise 2007-001). Divided into two legs, partway through *Hudson* returned to BIO for a crew change. The usual sampling, including Moving Vessel Profiler (MVP) surveys, was carried out along the standard seven lines. In addition, Seahorse and four other moorings were deployed at Station 2 on the Halifax Line, a wave rider buoy was deployed off Lunenburg and Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements were made as well as daily light meter profiles.

The next cruise was to the Scotian Shelf, Laurentian Channel and Orphan Basin (Igor Yashayaev, BIO) (Cruise 2007-007). The main purpose was to occupy oceanographic sections in the Laurentian Fan and Orphan Basin regions as a contribution to a joint DFO, PERD/industry study of the environmental factors affecting oil and gas exploration, to the DFO Ocean Climate Program and to the Climate Variability and Predictability Project (CLIVAR). Additional objectives were to deploy a calibration mooring and a Seahorse

profiling buoy on the Halifax Line, deploy two current meter moorings in the Laurentian Channel and recover and reset six current meter moorings in the Orphan Basin. The cruise terminated in St. John's, NL.

Departing from St. John's, the next cruise was to the Labrador Sea and Scotian Shelf (Ross Hendry, BIO) (Cruise 2007-011). This included participants from the Canadian Wildlife Service (CWS), Dalhousie, the University of Victoria, the University of Bergen and the Royal Netherlands Meteorological Institute. It was broken up into two legs with a brief personnel exchange near the end at BIO. The overall objective was to collect biological, chemical and physical field data needed to detect and measure inter-annual variability in the ecosystems of Atlantic Canadian continental shelves and slopes. The AR7W Line across the Labrador Sea was sampled for the 18th time in support of the newly established Atlantic Zone Off-Shelf Monitoring Program (AZOMP). The nearby L2 Line across the Labrador Sea was also sampled. The Halifax Line was also sampled in support of Atlantic Zone Monitoring Program (AZMP) as well as related offshore stations in support of the Atlantic Zone Off-Shelf Monitoring Program (AZOMP). These measurements contributed to the monitoring activities of the Global Climate Observing System (GCOS), the Global Climate Observing System (GCOS) and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The data collected provided a description of the inventories and export of biogenic carbon from the Labrador Sea as well as a description of plankton life cycles and productivity and its influence on ecosystems downstream. The impacts of deep-water formation on air-sea gas exchanges was also investigated. The relative abundance and distribution of pelagic birds was mapped to monitor long-term trends in Atlantic Canada. The long time series of near bottom temperature and currents in the Labrador Sea was extended by recovering and resetting a current meter mooring on the slope off Hamilton Bank. The international Argo program was supported by deploying nine profiling drifting floats in the Labrador Sea and along the Halifax Line. After a brief port call at BIO, the mooring development program was supported by recovering, servicing and redeploying several current meters along the Halifax Line. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated between stations during the cruise. No major problems were encountered and reasonable weather conditions allowed all primary scientific goals to be achieved. However, ice conditions prevented access to the most inshore stations at both ends of the AR7W Line across the Labrador Sea.

This was followed by a geological cruise to the Laurentian Channel and Grand Banks (Edward King, BIO) (Cruise 2007-016). Students from Dalhousie and Saint Mary's were involved. The purpose was to identify the geological conditions of the seabed and shallow sub-surface where modern surveys have not been conducted for the purposes of map development and geohazard assessment. Investigation of the shallow deposits on the continental shelf contributes to an improved understanding of geological history and better predictive capabilities for seabed infrastructure placement and seabed usage management. Equipment used included Hunttec DTS, airgun, sidescan sonar, gravity corer, IKU and van Veen grabs, RALPH and bottom cameras. The cruise terminated in Argentia, NL.

Next was another geological cruise to the Laurentian Fan and Grand Banks (Dave Mosher, BIO) (Cruise 2007-020). Students from Dalhousie, Daltech, Saint Mary's, Acadia and the University of New Brunswick were involved. The objective was to ground-truth recently acquired multibeam images of the Laurentian Fan to fully understand the geohazard potential of the region. The site of the 1929 Grand Banks failure was of particular interest. Equipment used included Huntec DTS, airgun, OBSs and sidescan sonar.

This was followed by a biological cruise to the Scotian Shelf and Grand Banks (Ellen Kenchington, BIO) (Cruise 2007-025). It was a collaborative effort with Memorial and the Centre for Marine Biodiversity to increase understanding of the benthos in previously unexplored areas along the continental slope and built upon the observations made on previous *Hudson* cruises. The primary sampling tool was the remotely operated vehicle (ROV) ROPOS (Remotely Operated Platform for Oceanographic Science) from Saanich, BC, which was installed on *Hudson* for the second time. The focus was on evaluating the distribution of deep-water corals and associated organisms in the Gully and at the Stone Fence off the edge of the Scotian Shelf and in the Haddock Channel and Desbarres Canyon off the edge of the Grand Banks. Researchers were able to collect video and still imagery as well as biological specimens and geological samples at depths down to 2,500 m. At the end of the program, *Hudson* proceeded to St. John's, NL to unload scientific staff and specimens before returning to BIO.

Next was a physical oceanographic cruise to the Scotian Shelf with participants from the Canadian Wildlife Service (CWS), Dalhousie and DFO Ottawa (Blair Greenan, BIO) (Cruise 2007-033). The top priority was to recover four moorings in the Gully which were deployed in April 2006 to measure currents, temperature and salinity. Work in the Gully also included measurements of temperature, salinity, oxygen, nutrients, chlorophyll, bacteria and zooplankton as well as Acoustic Doppler Current Profiler (ADCP) profiles. In addition, Station 2 along the Halifax Line was sampled for the Atlantic Zone Monitoring Program (AZMP), the Seahorse mooring at that location was recovered, refurbished and redeployed and a current meter mooring was deployed. Seabird and marine mammal observations were also made during the entire cruise.

This was followed by a cruise to the Scotian Shelf and Grand Banks (Ken Lee, BIO) (Cruise 2007-036). The objectives were to sample water, seabed sediment and benthic boundary layer suspended sediment for organic and inorganic contaminants associated with offshore oil and gas operations around the Thebaud and Terra Nova installations, recover samples of produced water from the Thebaud and Terra Nova platforms for toxicity studies, sample water, seabed sediment and benthic boundary layer suspended sediment for microbial biomass, community structure, activity and function, to sample seabed sediments for barite derived from drilling mud discharges and conduct seabed video surveys for comparison with previous records. Equipment used included Campod, slow-corer, BOB and bongo nets. The ship's Fast Rescue Craft (FRC) was used for sampling close to the platforms. Near the end of the cruise, a deep-water CTD Rosette

cast was made in the Gully for microbial analysis of bacterial community structure and function and water chemistry analysis.

Unfortunately, a new crane for the foredeck of the *Hudson* could not be installed in time for a joint GSCA-University of Quebec program in the Canada Basin so the planned cruise in September had to be cancelled.

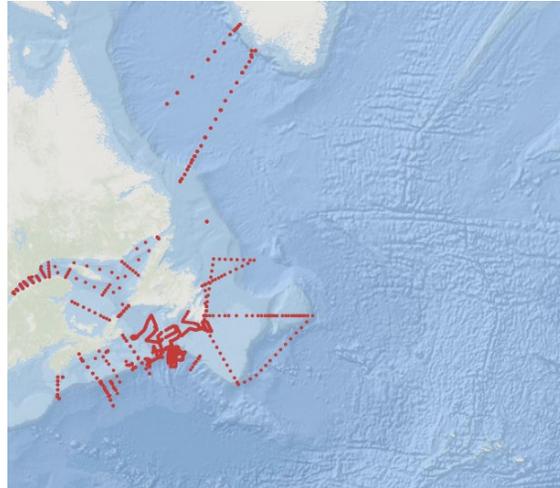
The next cruise was to the Scotian Shelf and Cabot Strait for the annual fall Atlantic Zone Monitoring Program (AZMP) cruise (Erica Head, BIO) (Cruise 2007-045). The cruise was divided into two legs with a quick personnel exchange at BIO. On board were scientists from Dalhousie, the University of Southampton, University of Liverpool and Canadian Wildlife Service (CWS). The main objective was to carry out the standard Atlantic Zone Monitoring Program (AZMP) surveys for temperature, salinity, oxygen, phytoplankton, zooplankton and acoustics along four transects across the Scotian Shelf and in Cabot Strait. In addition, Moving Vessel Profiler (MVP) deployments, equipped with a CTD, were made along the Browns Bank and Halifax lines plus sampling was done at four stations in the Gully, two off St. Pierre Bank and one off Banquereau. Moorings for a joint Canadian/UK program were recovered and reset in slope waters and additional moorings were recovered and reset at four stations along the Halifax Line. Drifters were deployed near the Halifax Line moorings and four Argo profiling floats were released at various locations. One of these was the 3000th float released in the global ocean as part of the international Argo program.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary (Alain Gagné, IML) (Cruise 2007-049). The main purpose was to carry out both the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, the biomass of zooplankton was evaluated using BIONESS and acoustics, six moorings were deployed in the Estuary and one mooring was replaced in the Strait of Belle Isle. A brief port call at Matane, QC was made partway through to disembark three staff.

The last cruise of the year was to the Grand Banks, Flemish Pass and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2007-053). This cruise had been moved from *Hudson* to *Teleost* earlier in the year as a cost-reduction measure but was moved back at the last minute due to problems on *Teleost*. Partway through, a port call was made into St John's, NL for a crew change. The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. Expendable bathythermographs (XBTs) were deployed between stations while the ship was underway. In addition, RAFOS profiling floats were deployed on the Flemish Cap in support of the international Argo program and an oceanographic mooring was recovered from Funk Island Bank. The distribution and abundance of pelagic seabirds were observed and recorded. On *Hudson's* return trip

from St. John's, a mooring on the Scotian Slope that had not surfaced in October was successfully recovered by grappling.

Upon return to BIO, Hudson spent the winter alongside.



Available cruise stations/tracks for 2007

2008

Cruises

Captains: Anthony Croft/Fergus Francey/ Paul Bragg/Dave Munn/Stan Nunn

Number of Cruises: 11

Days at Sea: 195

Nautical Miles Steamed (Estimated): 31,118

The first cruise was to the Scotian Shelf, Scotian Slope, Cabot Channel and the Grand Banks Slope (Ed Horne, BIO) (Cruise 2008-004). It was divided into two legs with a port call in between to the Coast Guard Base in Dartmouth to exchange personnel. The main purpose was to carry out the annual spring sampling of the Atlantic Zone Monitoring Program (AZMP) with participants from Dalhousie and the Canadian Wildlife Service (CWS). The usual sampling, including Moving Vessel Profiler (MVP) surveys, was carried out along the standard transects across the shelf. Sampling on the Halifax, Louisbourg, St. Pierre Bank and Grand Banks lines extended out to slope water in support of the newly established Atlantic Zone Off-Shelf Monitoring Program (AZOMP). In addition, an attempt was made by dragging to recover the missing Seahorse mooring, four other moorings were deployed on the Halifax Line, and Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements were made as well as daily light meter profiles. Also, listening buoys for marine mammals in the Gully were recovered and redeployed for Dalhousie University.

Next was a physical oceanographic cruise to the Scotian Shelf, Orphan Basin and Orphan Knoll with participants from Dalhousie and Waterloo universities (Igor Yashayaev, BIO) (Cruise 2008-006). The main purpose was to occupy oceanographic sections in the Orphan Basin and Orphan Knoll regions as a contribution to a joint DFO/ PERD/industry study of the environmental factors affecting oil and gas exploration, to the DFO Ocean Climate Program and to the Climate Variability and Predictability Project (CLIVAR). Additional objectives were to deploy a comparison mooring at Station 2 on the Halifax Line, recover and redeploy several current meter moorings in Emerald Basin along the Halifax Line, drag for one current meter mooring, recover six and deploy three in the Orphan Basin and deploy three current meter moorings on Orphan Knoll. The cruise terminated in St. John's, NL.

Departing from St. John's, the next cruise was to the Labrador Sea and Scotian Shelf with participation of the Canadian Wildlife Service (CWS) (Glen Harrison, BIO) (Cruise 2008-009). The overall objective was to collect biological, chemical and physical field data needed to detect and measure interannual variability in the ecosystems of Atlantic Canadian continental shelves and slopes. The AR7W Line across the Labrador Sea was sampled for the 19th time in support of the Atlantic Zone Off-Shelf Monitoring Program (AZOMP). The nearby L2 Line across the Labrador Sea was also sampled. The Halifax Line was also sampled in support of Atlantic Zone Monitoring Program (AZMP) as well as related offshore stations in support of the AZOMP. These measurements contributed to the monitoring activities of the Global Climate Observing System (GCOS) and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program (WCRP). The data collected provided a description of the inventories and export of biogenic carbon from the Labrador Sea as well as a description of plankton life cycles and productivity and its influence on ecosystems downstream. The relative abundance and distribution of pelagic birds was mapped to monitor long-term trends in Atlantic Canada. The long time series of near bottom temperature and currents in the Labrador Sea was extended by recovering and resetting a current meter mooring on the slope off Hamilton Bank. The international Argo program was supported by deploying numerous profiling drifting floats in the Labrador Sea and along the Halifax Line. A drifting buoy with a surface pCO₂ sensor for measuring atmospheric CO₂ uptake was deployed in the Labrador Sea. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was also operated between stations during the cruise. No major problems were encountered and all scientific goals were achieved. The absence of coastal ice conditions allowed the full occupation of the AR7W Line.

Next was a cruise to the Scotian Shelf for further studies of benthic communities which involved participation from Dalhousie University (Ellen Kenchington, BIO) (Cruise 2008-015). Partway through, a port call was made into Louisbourg, NS to exchange personnel. There were numerous objectives. The first was to return to the site of the hydraulic clam dredging experiment on Banquereau, initiated in 1998, to examine the recovery of the seabed and benthic communities from the disturbance. Sidescan sonar and Campod surveys were carried out and samples were collected using Videograb. Second was using Campod and Videograb to study numerous depressions in the Laurentian Channel and determine their origin. A third was using Campod and

Videograb to map the distribution of corals and sponges in Haldimand and Shortland canyons. These organisms denote vulnerable marine ecosystems which warrant protection from seabed disturbance. Fourth was to investigate the benthic communities on glacial moraines in the Gully MPA and their sensitivity to disturbance. While in the Gully, pop-up acoustic buoys were deployed to record whale communications.

This was followed by a cruise to the Grand Banks and the Gully which involved participants from the National Research Council and Concordia University (Ken Lee, BIO) (Cruise 2008-019). The objectives were to sample water, seabed sediment and benthic boundary layer suspended sediment for organic and inorganic contaminants associated with offshore oil and gas operations around the Terra Nova and Hibernia platforms, recover samples of produced water from both platforms for toxicity studies, sample water, seabed sediment and benthic boundary layer suspended sediment at both platforms for microbial biomass, community structure, activity and function and conduct seabed video surveys for comparison with previous records. Equipment used included Campod, slow-corer, BOB (Brother of BOSS) water sampler and bongo nets. The ship's Fast Rescue Craft (FRC) was used for sampling close to the platforms. Near the end of the cruise a deep-water CTD Rosette cast was made in the Gully MPA for microbial analysis of bacterial community structure and function and water chemistry analysis.

Next was a geophysical cruise to the Scotian Slope (Keith Loudon, DAL) (Cruise 2008-023). Using a sediment heat probe, detailed heat flow measurements were made to study the physical properties of sediment.

This was followed by a geological cruise to the Labrador Shelf (Dave Mosher, BIO) (Cruise 2008-027). The objective was to carry out a regional geohazard assessment of the seabed in the northern Labrador margin in support of potential exploration for oil and gas by industry. Equipment used included the Hunttec DTS, airgun, piston corer, IKU grab and bottom camera. The cruise terminated in Nain, NL.

Following a crew change in Nain, *Hudson* proceeded north to Davis Strait and Baffin Bay for another geological cruise (Calvin Campbell, BIO) (Cruise 2008-033). This was the cruise that had to be cancelled last year due to crane problems. It involved participation from the University of Quebec, Ohio State University, Dalhousie University, Durham University, Kent State University, the Institute of Arctic and Alpine Research (INSTAAR), University of Liege, University of Tübingen and the Alfred Wegener Institute. The prime objective was to collect data which would improve the understanding of the surficial geology, seabed conditions and paleoceanography of Davis Strait and Baffin Bay. A secondary objective was to collect information on physical and biological processes occurring in the overlying water column in order to calibrate some of the proxies used in paleoceanographic reconstructions. Equipment used included the Hunttec DTS, airgun, sidescan sonar, box corer, IKU and van Veen grabs, a CTD Rosette and plankton nets. During the cruise, *Hudson* reached 72.5° N, the farthest north she had been in many years. At the end of the program, *Hudson* returned to BIO.

The next cruise was to the Scotian Shelf and Cabot Strait (Ed Horne, BIO) (Cruise 2008-037). This was the annual fall Atlantic Zone Monitoring Program (AZMP) cruise which was divided into three legs. Also participating were scientists from Dalhousie University and the University of Liverpool. The main objectives were to obtain synoptic fall observations of the hydrography and the distributions of nutrients, phytoplankton, zooplankton and bacteria along three sections on the Scotian Shelf and one in Cabot Strait, retrieve moorings along a section across the slope waters of the central Scotian Shelf, deploy moorings along the extension of the Halifax Line and collect hydrographic profiles and water samples at mooring stations. This part of the program was in collaboration with members of the UK RAPID-WAVE (West Atlantic Variability Experiment) program. Additional objectives were to carry out hydrographic, chemical and biological sampling at stations in the Gully and Roseway Basin and at stations along a transect across the Northeast Channel, measure underwater light fields and levels of coloured dissolved organic material, monitor temperature, salinity and phytoplankton fluorescence continuously in the near surface using a flow-through pumping system, deploy an APEX profiling float in the slope waters off Banquereau, examine the vertical distribution of mesozooplankton at depths of up to 1,000 m beyond the shelf-break, investigate the vertical distribution of krill in the Northeast Channel, the shelf basins, the Gully and Cabot Strait, record acoustic back-scattering along the ship's track, deploy/recover moorings at Station 2 on the Halifax Line, identify and enumerate seabirds during transit between stations and lines, collect and preserve water samples for analysis of carbon dioxide levels and pH, retrieve whale listening acoustic moorings in Shortland and Haldimand canyons, deploy drifters off Cape Breton and Newfoundland and collect stage V *Calanus finmarchicus* at their overwintering depths to measure lipid content. The core Atlantic Zone Monitoring Program (AZMP) sampling was successfully completed. Unfortunately, early in the second leg, the CTD Rosette was lost during retrieval because of an inexperienced winch operator. It was recovered from 150 m of water a few months later by a commercial company using an unmanned submersible.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary which was divided into two legs with a personnel exchange partway through at Matane, QC (Michel Harvey/Alain Gagné, IML) (Cruise 2008-045). The main purpose was to carry out both the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, the biomass of zooplankton was evaluated using BIONESS and acoustics, moorings were deployed in the Estuary and a mooring in the Strait of Belle Isle was replaced.

The last cruise of the year was to the Grand Banks, Flemish Pass and Northeast Newfoundland Shelf (Eugene Colbourne, NAFC) (Cruise 2008-047). Two port calls were made into St. John's, NL to exchange personnel. The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The designated transects were now the Seal Island, Bonavista, Flemish Cap and Southeast Grand Banks lines. The usual physical, chemical and biological variables were measured using a CTD Rosette and

zooplankton were collected using vertical plankton nets. Expendable bathythermographs (XBTs) were deployed between stations while the ship was underway. In addition, a profiling float was deployed on the Southeast Grand Banks transect in support of the international Argo program and the abundance of pelagic seabirds was observed and recorded.

Hudson then returned to BIO and was docked for the winter.



Available cruise stations/tracks for 2008

2009

Replacement of the aging scientific research fleet remained a high priority. A contract for designing a *Hudson* successor was now expected to be let in 2010.

In November, the BIO Oceans Association organized an event at BIO to celebrate the 40th anniversary of the departure of *Hudson* on the Hudson 70 Expedition. Over 50 of the original participants, both crew and scientific staff, attended and enjoyed presentations, a reception and a tour of the ship which featured series of displays depicting this epic voyage. Each participant was presented with a commemorative coin engraved with a map of the expedition and a pen crafted from a section of the *Hudson*'s teak railing. One of the presentations was the song *The Mighty Hudson*, written by Philip Spencer (GSCA) and sung by Patrick Potter (GSCA). Many old friendships were rekindled at this event. There was a true feeling of a family getting together to share fond memories of the 'good old days'. The warm relationship among the ship's crew and the scientific staff was a

reminder of the essential requirement of teamwork for careful observations of the oceans and making important discoveries.

The Great Ocean of Truth by Peter Wadhams was published. This was his personal story of participating as a technician in the entire Hudson 70 Expedition.

Cruises

Captains: Dave Munn/ Dave Martin/Paul Bragg/ Bill Naugle

Number of Cruises: 11

Days at Sea: 202

Nautical Miles Steamed (Estimated): 32,118

The first cruise of the year was to the Scotian Shelf, Scotian Slope, Cabot Strait and the Grand Banks Slope (Ed Horne, BIO) (Cruise 2009-005). The main purpose was to carry out the annual spring sampling of Atlantic Zone Monitoring Program (AZMP) for the Maritimes Region with participants from Dalhousie University, University of Alberta, Laval and the Canadian Wildlife Service (CWS). This was divided into two legs with a port call partway through at BIO to exchange personnel. The usual sampling, including Moving Vessel Profiler (MVP) surveys, was carried out along the standard transects across the shelf. In addition, sampling on the Halifax, Louisbourg, St. Pierre Bank and Grand Banks lines was extended out into slope water in support of the Atlantic Zone Off-Shelf Monitoring Program (AZOMP). In addition, a Seahorse mooring and four other moorings were deployed on the Halifax Line, Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements were made and daily light meter profiles were collected.

Departing from BIO, the next cruise was to the Gully, Laurentian Channel, Orphan Knoll and Orphan Basin (Igor Yashayaev, BIO) (Cruise 2009-011). Also participating were scientists from Dalhousie and University of Alberta. A stop was made partway through into St. John's, NL to exchange personnel. The main objective was to occupy oceanographic sections in the Laurentian Fan, Orphan Basin and Orphan Knoll regions as a contribution to a joint DFO/PERD/industry study of environmental factors affecting oil and gas exploration, the DFO Ocean Climate program, the Climate Variability and Predictability Project (CLIVAR) and International Governance Strategy (IGS). In addition, two moorings were recovered in the Sable Gully region, two current meter moorings were deployed in the Laurentian Fan region, three current meter moorings were recovered and two deployed in Orphan Basin and three current meter moorings were recovered and redeployed on and around Orphan Knoll. The bottom sounder and the Acoustic Doppler Current Profiler (ADCP) were operated between stations throughout the cruise which ended in St. John's, NL.

Departing from St. John's, the next cruise was to the Labrador Sea and Scotian Shelf with participation of the Canadian Wildlife Service (CWS), McGill University, the Royal Military College and the Woods Hole Oceanographic Institution (WHOI) (Ross Hendry, BIO) (Cruise 2009-015). This cruise continued the annual series measurements in the

Labrador Sea which began in 1990 which has evolved into a component of a multidisciplinary regional monitoring effort. The broad goals were to investigate interannual and long-term changes in the physical and chemical properties of the Labrador Sea and better understand the mechanisms that cause these changes. A particular focus was on changes in the intensity of winter overturning of surface and intermediate depth waters and the resulting formation of Labrador Sea Water with varying temperature and salinity properties. This overturning is part of the thermohaline circulation that plays a critical role in the global climatic system. Convection also transfers atmospheric gases such as oxygen and carbon dioxide from the surface layers to intermediate depths. The resulting oceanic storage of anthropogenic carbon reduces the rate of increasing carbon dioxide in the atmosphere but also increases the acidity of oceanic waters. The physical-chemical investigations were part of a larger multidisciplinary program seeking a better understanding of interannual and long-term changes in regional ecosystems. Specific operations included a CTD Rosette survey of numerous physical and chemical variables along Line 3 across the Labrador Sea, recovery and redeployment of a current meter mooring on the Labrador Slope, current measurements from a ship-mounted Acoustic Doppler Current Profiler (ADCP), temperature profiles using XBTs, autonomous float deployments as part of the international Argo project, physical and chemical measurements at Station 27 on the Newfoundland Shelf and the Halifax Line on the Scotian Shelf in support of Atlantic Zone Monitoring Program (AZMP), physical and chemical measurements on the Scotian Slope in support of Atlantic Zone Off-Shelf Monitoring Program (AZOMP) and measurements of light carbonyl compounds, ozone, nitrogen oxides and non-methane hydrocarbons in surface water and marine air. The work went well except for heavy ice on the Labrador coast which prevented access to stations on the shelf and slope. Ice conditions made it necessary to return to BIO by way of Cape Race rather than the shorter route through the Strait of Belle Isle and Gulf of St. Lawrence.

Hudson then returned to the Labrador Sea in June to conduct further geophysical studies (Sonya Dehler, BIO) (Cruise 2009-019). This cruise was conducted in collaboration with the Geological Survey of Denmark and Greenland (GEUS) with participation of Dalhousie University. It was part of their respective continental shelf programs under the United Nations Convention of the Law of the Sea (UNCLOS) Article 76. Wide-angle reflection and refraction seismic data were collected south of Greenland, in the central Labrador Sea and in Orphan Basin using an airgun array as the seismic source. Ocean bottom seismometers and sonobuoys were used for recording signals. During the cruise, *Hudson* had to take shelter from a hurricane along the coast of Greenland. Later, she rescued the seven-man crew of the fishing vessel *Ocean Commander* which burned and sank on the Grand Banks. The cruise ended in St. John's, NL.

The next cruise was to the Grand Banks and Scotian Shelf (Ellen Kenchington, BIO) which departed from St. John's (Cruise 2009-030). The overall objective was to conduct targeted benthic surveys to locate and validate the presence of vulnerable marine ecosystems (VMEs) in the NAFO Regulatory Area. The major tools were Campod, Videograb, a bottom camera and CTD. As a Canadian contribution to the NAFO Potential Vulnerable Marine Ecosystem Impacts of Deep-sea Fisheries Program

(NEREIDA), *Hudson* conducted drop-camera and video studies of sponge concentrations on the slopes of the Flemish Cap. Other sampling sites on the Grand Banks included Orphan Basin, Sackville Spur, Antonio's Patch and Beothuk Knoll. The *Hudson* then returned to the Stone Fence Coral Conservation Area where, after a five-year closure to fishing, a recovery of corals was noted. Finally, the first video and camera surveys were conducted around St. Ann's and Missaine banks which are candidate areas for new MPAs.

This was followed by a cruise to the Gulf of Maine (Peter Lawton, SABS) (Cruise 2009-031). *Hudson* worked in the Gulf of Maine Discovery Corridor conducting video surveys and benthic ecological studies as part of the first Canadian Healthy Oceans Network (CHONe) program. CHONe was a strategic network focused on biodiversity science for the sustainability of Canada's three oceans and included researchers from 15 universities across Canada, DFO, and seven other government laboratories. This cruise hosted research teams from Dalhousie and Memorial universities, including four CHONe graduate students. The primary benthic sampling systems used were Campod for seabed video and photo acquisition and a multicorer system supplied by Memorial for replicated sediment cores. The cruise obtained additional marine geological and benthic habitat information which was used for planning 2010 studies employing the deep-water Remotely Operated Vessel ROPOS for high-resolution imaging and sample collections.

The next cruise was to the Bay of Fundy (Brian Todd, BIO) (Cruise 2009-039). The purpose was to collect geological information to enable the scientific interpretation of multibeam sonar data recently collected in collaboration with the Canadian Hydrographic Service (CHS) and the University of New Brunswick to assist in the creation of seafloor surficial geology maps. Geophysical surveying and geological sampling were also carried out in all parts of the Bay of Fundy ranging from the mouth between Grand Manan and Briar Island to Cape Chignecto. The program included seismic profiling, sidescan sonar surveys, piston coring, bottom photography using Campod and sampling using Videograb and IKU grab.

This was followed by a geological cruise to the Laurentian Channel and Grand Banks (Edward King, BIO) (Cruise 2009-044). Students from Dalhousie, Memorial and Waterloo universities were involved. The purpose was to continue studies of the geological conditions of the seabed and shallow subsurface for the purposes of map production and geohazard assessment, mainly to fill in areas where modern surveys had not yet been conducted. The data were expected to contribute to an improved geological history and better predictive capabilities for seabed infrastructure placement and seabed usage management. Seabed core sampling was a primary focus but IKU grab samples were also collected. In addition, seabed photographs were taken. Geophysical surveying using Hunttec DTS and airgun was done to help selected sampling stations.

Next was a cruise to the Scotian Shelf, Scotian Slope, Cabot Strait and Grand Banks Slope (Ed Horne, BIO) (Cruise 2009-048). There were three legs with personnel exchanges at BIO in between. It included participants from the Proudman Oceanographic Laboratory, Dalhousie, Laval and the University of Maine. This cruise

was for the annual fall sampling for Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) in the Maritimes Region. In addition, Moving Vessel Profiler (MVP) deployments were made along three lines, samples were collected in the Gully, moorings for a joint Canadian/UK program were recovered and redeployed in Scotian Slope water, four Argo profiling floats were deployed, a mooring off Cape Sable was recovered and replaced, Seahorse and Carioca moorings were placed at Station 2 on the Halifax Line, three Ocean Tracking Network (OTN) moorings were recovered and replaced and dragging was done for a lost wire and release.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary which was divided into two legs with a personnel exchange partway through at Matane, QC (Jacques Gagné/Alain Gagné, IML) (Cruise 2009-055). Personal from Laval and Dalhousie universities also participated. The main purpose was to carry out both the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, the biomass of zooplankton was evaluated using BIONESS and acoustics, moorings in the Estuary and Strait of Belle Isle were recovered and replaced and sediments were collected by box corer.

The final cruise of the year was to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2009-059). *Hudson* departed from and returned to St. John's, NL. The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The designated transects were now Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank and St. Pierre lines. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. Acoustic Doppler Current Profiler (ADCP) data were collected while underway along the transects. In addition, one Argo profiling float was deployed on the slope at the end of Southeast Grand Bank line in support of the international Argo program and the abundance of pelagic seabirds were observed and recorded.

At the end of this cruise, *Hudson* returned to St. John's, NL for dry docking and refit over the winter.



Available cruise stations/tracks for 2009

2010

Cruises

Captains: Mike Hemeon/Bill Naugle/Dave Martin/Stan Nunn

Number of Cruises: 13

Days at Sea: 173

Nautical Miles Steamed (Estimated): 27,500

The first cruise of the year was to the Scotian Shelf, Scotian Slope and Cabot Strait which included participants from the Canadian Wildlife Service (CWS) and Dalhousie (Ed Horne, BIO) (Cruise 2010-006). The main purpose was to carry out the annual spring sampling for Atlantic Zone Monitoring Program (AZMP). It was divided into two legs with a personnel exchange by Fast Rescue Craft (FRC) off Sambro, NS. The usual sampling, including Moving Vessel Profiler (MVP) surveys, was carried out along the standard transects across the shelf. In addition, sampling on the Halifax, Louisbourg and St. Pierre Bank lines extended out into slope water in support of Atlantic Zone Off-Shelf Monitoring Program (AZOMP). A Seahorse mooring and five other moorings were deployed on the Halifax Line, Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements were made and daily light meter profiles were collected.

This was followed by a cruise to the Laurentian Fan, Orphan Knoll and Orphan Basin which was divided into two legs with a crew change in St. John's, NL (Igor Yashayaev, BIO) (2010-009). It included participants from the Canadian Wildlife Service (CWS), Dalhousie and the University of Alberta. The main purpose was to occupy oceanographic sections in the Laurentian Fan, Orphan Basin and Orphan Knoll regions as a contribution to a joint DFO/ PERD/industry study of the environmental factors affecting oil and gas exploration, the DFO Ocean Climate Program and the Climate Variability and Predictability Project (CLIVAR). In addition, two current meter moorings were redeployed in the Laurentian Fan, two Argo floats were released at the Laurentian Fan, two current meter moorings were recovered in Orphan Basin and one

current meter mooring was recovered and redeployed over Orphan Knoll. An Acoustic Doppler Current Profiler (ADCP) was operated during the entire cruise. The cruise terminated in St. John's, NL.

Next was a cruise to the Labrador Sea, Laurentian Fan and Scotian Shelf involving participants from Memorial, the University of Washington and the National University of Ireland (Glen Harrison, BIO) (Cruise 2010-014). There were numerous objectives. The first was to collect physical, chemical and biological field data needed to detect and measure interannual variability in ecosystems of the Atlantic Canadian shelves and slopes. Sampling was done along the AR7W section across the Labrador Sea, on the Halifax Line and related offshore stations in support of both Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). The data collected contributed to the monitoring goals of the Global Ocean Observing System and the Global Climate Observing System and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program. Another objective was to provide a description of the inventories and export of biogenic carbon in the Labrador Sea and provide a description of plankton life-cycles and productivity in the Labrador Sea and its influence on ecosystems downstream. In addition, the relative abundance and distribution of seabirds was mapped. The long time series of near-bottom temperature and currents on the slope off Hamilton Bank in the Labrador Sea was extended by recovering and resetting a current meter mooring. The international Argo program was supported by deploying profiling drifting floats in the Labrador Sea and on the Halifax Line. And finally, the near-surface gradients of salinity and turbulence were studied using the Air-Sea Interaction Profiler (ASIP), an autonomous upwardly-rising instrument with a suite of high-resolution sensors to measure a variety of variables from the mixed layer to the air-sea interface. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated throughout the cruise. Several days were lost due to stormy weather and heavy ice prevented working close to the Labrador coast. However, most objectives were satisfactorily attained.

Next was a geological cruise to the Grand Banks involving participants from Dalhousie, Saint Mary's and Acadia (Michael Li, BIO) (Cruise 2010-020). The cruise was undertaken for the Geoscience for East Coast Offshore Development (GECOD) project within the GSC Offshore Geoscience Program. The main objectives were to obtain improved knowledge of distribution, metrics and sediment composition of bedforms in identified areas of high bedform mobility, establish new and extend existing serial sidescan sonar coverage at selected sites for bedform mobility assessment and study foundation conditions and geologic framework through geophysical surveys and core sampling with a focus on pipeline corridors. Equipment used included van Veen and IKU grabs, long piston corer, bottom cameras, dredge sampler, airgun, sidescan sonar and Hunttec DTS. Seabed images, samples, and cores for a total of 62 stations as well as 700 km geophysical survey lines were collected over seven study areas spanning the entire Grand Banks region including St. Pierre Bank, central, eastern and northeastern Grand Bank, Downing Moraine and Trinity Trough. The cruise terminated in St. John's, NL.

Next was a cruise to the Newfoundland Shelf with participants from Memorial University (Calvin Campbell, BIO) (Cruise 2010-023). The purpose was to investigate a recently discovered submarine landslide and extensive zone of seafloor instability on Funk Island Bank and to improve understanding of the surficial geology, seafloor properties and processes on the continental slope between Orphan Spur and Hamilton Spur, an area where little historical data exist. Equipment used included Huntec DTS, airgun, sidescan sonar, IKU grab, long piston corer and bottom camera.

This was followed by a cruise to the Gully MPA, Flemish Cap, Orphan Knoll and Tobin's Point (Ellen Kenchington, BIO) (Cruise 2010-029). It involved the use of ROPOS to collect imagery and biological specimens of benthic epifauna. In addition to the eight-member ROPOS team, there were participants from Memorial, Dalhousie, the University of Quebec at Montreal and the Centro Oceanográfico Vigo (Spain). The main objective was to increase understanding of deep-sea benthos such as corals and sponges in biologically important and unexplored areas. Specific objectives were to deploy and recover a current meter mooring in the Gully to better understand the microhabitat selection processes of corals, collect coral specimens to better understand their reproductive ecology and genetic connectivity, assess the impact of trawling on deep-sea vulnerable marine ecosystems in areas of Flemish Cap recently dedicated as closed by NAFO, collect rock, sediment and dead corals to better understand current and past geological processes, explore mounds of unknown origin on Orphan Knoll, retrieve two moorings around Orphan Knoll, collect data on groundfish distribution and abundance at Tobin's Point and collect CTD data at the Flemish Cap, Orphan Knoll and Tobin's Point.

Next was another biological cruise to the Gulf of Maine and Northeast Channel which was broken into two legs with a crew change in Shelburne, NS (Peter Lawton, SABS) (Cruise 2010-033). It involved the further use of ROPOS to collect imagery and biological specimens of benthic epifauna. In addition to the ROPOS team, there were participants from Memorial, Dalhousie, Laval and the University of Victoria. This cruise was another collaborative effort between DFO, Dalhousie, Laval and Memorial as partners in the first Canadian Healthy Oceans Network (CHONe) program to increase understanding of marine biodiversity patterns and processes in the Gulf of Maine. The survey locations were all within the Discovery Corridor, the area previously chosen as a focus for marine biodiversity research efforts in the region. ROPOS was used to explore deep-water sites using still and video imagery, collect faunal samples and also retrieve benthic sediment arrays previously deployed in 2006. Additional benthic studies were done using Multicorer, a surface-deployed soft-sediment sampling tool. A microbial ecology study was conducted using a CTD Rosette to investigate the diversity of microbial communities in relation to water masses and water column structure. And finally, seabird and marine mammal surveys were made during the daylight hours to investigate the relationship between upper trophic level predators and water mass characteristics and complexity.

Next was a short geological cruise to the Labrador Shelf (Gary Sonnichsen, BIO) (Cruise 2010-040).

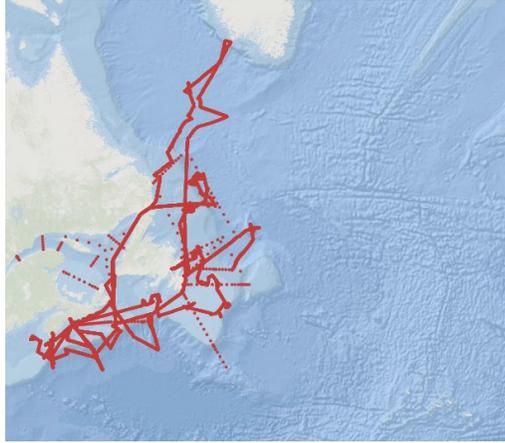
This was followed by a cruise to Hudson Bay and the Foxe Basin (Mathieu Duchesne, GSC) (Cruise 2010-041).

Next was a cruise to Hudson Bay and Hudson Strait (Patrick Lajaunesse, Laval (Cruise 2010-046).

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary which was divided into two legs with a crew exchange partway through in Sydney, NS (Alain Gagné, IML) (Cruise 2010-055). Personnel from the Canadian Wildlife Service (CWS) participated. The main purpose was to carry out both the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. In addition, data on the distribution and abundance of krill in the St. Lawrence Estuary were collected using a JackNet, two Aural moorings were deployed and seabird surveys were conducted. Also, unsuccessful attempts were made to recover a lost rosette by dragging. The cruise terminated in Sydney, NS.

Hudson then steamed to St. John's, NL for the next cruise to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2010-057). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects were now Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank and the St. Pierre lines. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. Expendable bathythermographs (XBTs) were deployed while underway between stations and seabird surveys were also carried out. The cruise ended in St. John's, NL.

Hudson then steamed back to BIO for the last cruise of the year to the Scotian Shelf (Ed Horne, BIO) (Cruise 2010-049). The main purpose was to carry out the standard fall sampling along the Halifax Line for Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) for the Maritimes Region. In addition, moorings for the Rapid program were recovered and redeployed at the seaward end of the Halifax Line, the Carioca moorings at Station 2 were replaced and one Ocean Tracking Network (OTN) mooring was recovered and replaced.



Available cruise stations/tracks for 2010

2011

Cruises

Captains: Dave Martin/Paul Bragg/Ken Brown/Bill Naugle

Number of Cruises: 9

Days at Sea: 168

Nautical Miles Steamed (Estimated): 26,712

The first cruise of the year was to the Scotian Shelf, Scotian Slope and Cabot Strait which included participants from Dalhousie (Ed Horne, BIO) (Cruise 2011-004). It was divided into two legs with a personnel exchange by Fast Rescue Craft (FRC) off Sambro, NS. The main purpose was to carry out the annual spring sampling for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) in the Maritimes Region. The usual sampling, including Moving Vessel Profiler (MVP) surveys, was carried out along the standard transects across the shelf and slope. In addition, a Seahorse mooring and five other moorings were deployed on the Halifax Line, five moorings and three guard buoys were recovered, Acoustic Doppler Current Profiler (ADCP) and multi-frequency sonar measurements were made and daily light meter profiles were collected. The cruise also extended long-term biological studies to describe the large-scale variability in plankton biomass, productivity and biogenic carbon inventories on the Scotian Shelf as part of continuing climate and ecosystem studies. The cruise was most successful and all objectives were achieved.

The next cruise was to the Scotian Shelf, Scotian Slope, Laurentian Fan and Labrador Sea which included participants from the Canadian Wildlife Service (CWS), Memorial and the University of Victoria (Igor Yashayaev, BIO) (Cruise 2011-009). There were numerous diverse objectives. Physical, chemical and biological data were collected to measure interannual variability in ecosystems of Atlantic Canadian shelves and slopes. Physical, chemical and biological data were collected along the AR7W section across the Labrador Sea, along the Halifax Line and at related offshore stations in support of the

Atlantic Zone Monitoring Program (AZMP) and the Atlantic Zone Off-Shelf Monitoring Program (AZOMP). This information contributed to the monitoring goals of the Global Ocean Observing System and the Global Climate Observing System and the research activities of the Climate Variability and Predictability Project (CLIVAR) of the World Climate Research Program. A description was provided of the inventories and export of biogenic carbon from the Labrador Sea as well of plankton life-cycles and productivity in the Labrador Sea and its influence on ecosystems downstream. The relative abundance and distribution of pelagic seabirds was also determined. The long time series of near-bottom temperature and currents on the slope off Hamilton Bank in the Labrador Sea were extended by recovering and resetting a current meter mooring. In addition, two deep current meter moorings were recovered on the Laurentian Fan. And finally, in support of the international Argo network, profiling drifting floats were deployed in the Labrador Sea and along the Halifax Line. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated during the entire cruise. The cruise was most successful and no major problems were encountered.

This was followed by a biological cruise to the Scotian Shelf and Laurentian Channel (Ellen Kenchington, BIO) (Cruise 2011-014). The purpose was to collect further information on benthic communities using Campod and Videograb as the primary sampling tools. Work in Emerald Basin focused on large sponges, commonly known as Russian hats, and their vulnerability to fishing activity. Work in the Laurentian Channel focused on sea pens while that in the Gully focused on deep-water corals. The latter information was expected to contribute to ecosystem modelling and management of the Gully MPA.

Next was a cruise to the Scotian Shelf and Grand Banks (Les Burrige, SABS) (Cruise 2011-017). The purpose was to conduct further studies on the effects of operational drilling wastes discharged from active production platforms. The first operation was sampling at the Terra Nova Floating Production Storage and Offloading (FPSO) vessel on the Grand Banks after which *Hudson* steamed to the Venture platform on Sable Island Bank. Seawater samples were collected along transects radiating out from the platforms for analysis of inorganic and organic contaminants plus microbial biomass. Samples of produced water before discharge were obtained from the platforms for toxicity studies. Zooplankton were collected at reference sites to determine their sensitivity of produced water. The data collected will be used to validate the Dose-related Risk and Assessment Model (DREAM) to predict the movement, concentration and environmental risk of produced water discharges at sea. The impacts of oil sheens generated from produced water effluents were also assessed. The ship's Fast Rescue Craft (FRC) was used to collect water samples within the 500 m exclusion zones around the platforms.

This was followed by a geological cruise to Flemish Pass and Grand Banks which involved the participation of Dalhousie and several Spanish scientists (Calvin Campbell, BIO) (Cruise 2011-031). The general objectives were to improve understanding of the surficial geology, seafloor properties and processes on the continental slope. Specific objectives were to assess regional surficial geology framework in the area of petroleum basins east of the Grand Banks, evaluate specific geohazards, carry out coring and high

resolution seismic surveys to assess foundation conditions for seafloor structures, evaluate constraints to exploratory drilling and measure sediment transport in the Labrador Current. Equipment used included Hunttec DTS, airgun, piston cores, IKU grab, box corer and RALPH, the instrumented deep lander for measuring sediment transport. The latter was deployed at the start of the cruise and recovered at the end.

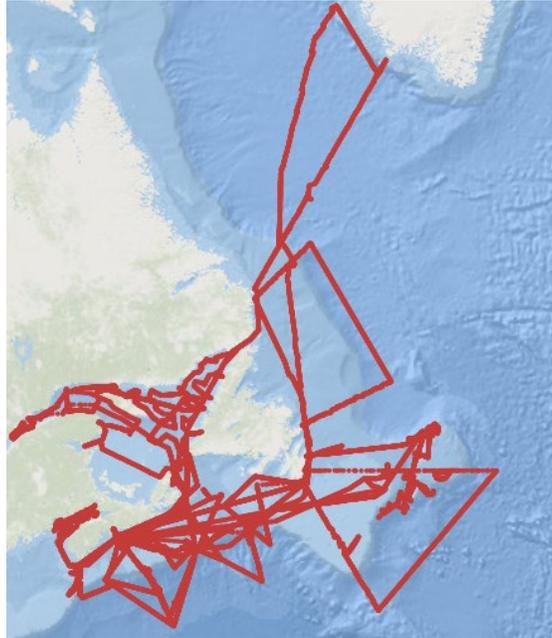
This was immediately followed by another geological cruise to the Bay of Fundy (Brian Todd, BIO) (Cruise 2011-036). The purpose was to collect further information on seabed properties to interpret multibeam data and create surficial geology maps of the seafloor. Sampling equipment included Hunttec DTS, a deep-water camera, Campod, IKU grab and corers. Sampling was carried out all the way from the mouth of the Bay up to Minas Channel and Chignecto Bay. Seabed landers were deployed at the start of the cruise and recovered at the end.

Next was a cruise to the Scotian Shelf which was divided into two legs with a staff change in between at BIO and involved Dalhousie University (Erica Head, BIO) (Cruise 2011-043). The main purpose was to carry out the standard fall sampling along the various lines for Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). In addition, current meter moorings were deployed on the Halifax Line while several Ocean Tracking Network (OTN) buoys were recovered and redeployed, six current meter moorings were recovered and redeployed on the Roseway Bank Line and an acoustic mooring was recovered in the Gully.

This was followed by an October cruise to the Gulf of St. Lawrence and St. Lawrence Estuary which was divided into two legs with a staff change at Gaspé, QC (Pierre Joly/Alain Gagné, IML) (Cruise 2011-050). Personnel from the Canadian Wildlife Service (CWS) participated. The main objective of the first leg was to describe the structure and vertical distribution of krill and *Calanus* communities in the northern Gulf in relation to various environmental variables including oxygen and pH. A secondary objective was to retrieve four passive acoustic moorings. The main objective of the second leg was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program. The usual physical, chemical and biological variables were measured using a CTD Rosette. Other objectives included measuring pH and alkalinity to evaluate current conditions in the Laurentian Channel and understanding how light propagates in the water column in order to better interpret satellite images of ocean colour to provide information on phytoplankton biomass. For the second consecutive year, the concentration of nitrous oxygen in seawater, a major greenhouse gas pollutant, was measured. Seabird surveys were also conducted. The cruise ended at BIO but *Hudson* then sailed to St. John's, NL for the next cruise.

The final cruise of the year was to the Grand Banks which departed from St. John's (Eugene Colbourne, NAFC) (Cruise 2011-051). The main purpose was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and some additional sampling was carried out at Station 27 in Trinity Bay and Hibernia.

Expendable bathythermographs (XBTs) were deployed while underway between stations. Seabird surveys were also carried out. The cruise ended in St. John's, NL.



Available cruise stations/tracks for 2011

2012

The drilling moratorium on the Canadian sector of Georges Bank was extended to 2022.

Delays in the construction of a successor vessel were now obvious. *Hudson* was now 50 years old, considerably older than her initial expected service life of approximately 35 years. It was realized that considerable effort would be needed to prolong her service life and carry out the upgrades required to comply with new regulations. This was particularly the case for the generators and propulsion motors.

The start of the field season was delayed this year due to the need for further major repairs. These included steel work on the bridge, boat and upper decks while alongside at BIO.

The book entitled *Getting Around the Americas* by Charles Schafer and Roger Smith was published. This was their account of the Hudson 70 Expedition. Both were participants in several of the legs.

Cruises

Captains: Ken Brown/Dave Martin

Number of Cruises: 3

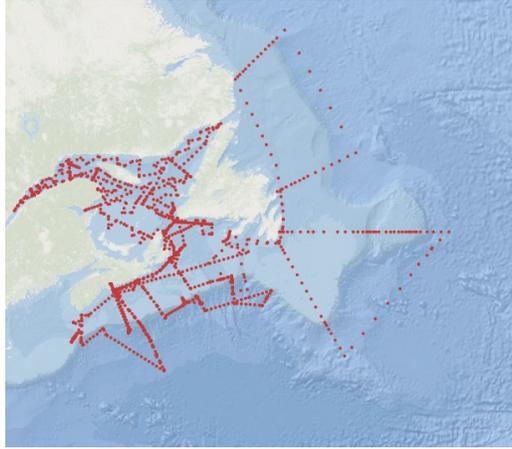
Days at Sea: 66

Nautical Miles Steamed (Estimated): 10,494

Due to the major repairs, the first cruise the year was not until the early fall to Scotian Shelf, Scotian Slope and Cabot Strait (Ed Horne, BIO) (Cruise 2012-042). It was divided into three legs with staff changes at BIO and Sydney, NS. It included participants from the Canadian Wildlife Service (CWS) and Dalhousie. The main purpose was to carry out the annual sampling along the standard transects for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) in the Maritimes Region. In addition, moorings were recovered on St. Ann's Bank, dragging for a Rapid mooring was carried out and acoustic buoys were deployed in the Gully to record whale sounds. Throughout the cruise, currents were measured with the ship-mounted Acoustic Doppler Current Profiler (ADCP). Seabird and marine mammal observations were also made during daylight hours. The cruise was most successful with all objectives achieved.

Departing from Gaspé, the next cruise was to the Gulf of St. Lawrence and St. Lawrence Estuary which was divided into two legs (Pierre Joly/ François Villeneuve, IML) (Cruise 2012-045). Personnel from the Canadian Wildlife Service (CWS) participated. The main objectives were to conduct the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, phytoplankton and zooplankton. In addition, the spatial arrangement of the AZMP transects for describing the abundance and biomass of key zooplankton species was examined in relation to various environmental variables including oxygen and pH. Larval and juvenile krill were sampled using a jack-net equipped with a strobe light to estimate a recruitment index in the Gulf of St. Lawrence. Four passive acoustic moorings were retrieved. Other objectives included measuring pH and alkalinity to evaluate present conditions in the Laurentian Channel and understanding how light propagates in the water column in order to better interpret satellite images of ocean colour that provide information on phytoplankton biomass. For the third consecutive year, the concentration of nitrous oxygen in seawater, a major greenhouse gas pollutant, was measured. Seabird surveys were also conducted. The cruise ended at BIO but *Hudson* then sailed to St. John's, NL for the next cruise.

The next cruise was to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2012-046). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects were now Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank and the St. Pierre lines. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. In addition, Acoustic Doppler Current Profiler (ADCP) data were collected while underway and seabird surveys were carried out. The cruise ended in St. John's, NL.



Available cruise stations for 2012

2013

Cruises

Captains: Dave Martin/Rick Cotie

Number of Cruises: 10

Days at Sea: 185

Nautical Miles Steamed (Estimated): 29,415

The first cruise of the year was to the Scotian Shelf and Cabot Strait (Dave Hebert, BIO) (Cruise 2013-004). It was divided into two legs with a staff change at BIO and included participants from the Canadian Wildlife Service (CWS), Dalhousie and the UK National Oceanography Centre. The main objectives were to carry out the annual spring observations for Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) along the standard transects and to retrieve and deploy moorings along the Halifax Line as part of the UK RAPID-WAVE (West Atlantic Variability Experiment) program. In addition, acoustic listening moorings were recovered in the Gully, three bottom-mounted Acoustic Doppler Current Profiler (ADCP)/CTD moorings were turned around for the Ocean Tracking Network (OTN) and a bottom-mounted Acoustic Doppler Current Profiler (ADCP)/CTD mooring and high-flier thermistor chain were deployed on St. Ann's Bank. Seabird and marine mammal observations were also made during daylight hours. No equipment problems were experienced and the cruise was most successful.

Next was a cruise to the Scotian Shelf, northwest Atlantic and Labrador Sea (Igor Yashayaev, BIO) (Cruise 2013-008). Included were participants from Dalhousie, Memorial, University of Southern California, the UK National Oceanographic Centre, France and Germany. The cruise departed from and returned to BIO. The many objectives were to collect physical, chemical, and biological data needed to detect and measure interannual variability in ecosystems of the Atlantic Canadian shelves and slopes, provide a description of the interannual variations in physical, chemical, and

biological properties along the AR7W section across the Labrador Sea and related offshore stations in support of the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP), contribute to the monitoring goals of the Global Ocean Observing System and the Global Climate Observing System and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program, provide a description of the inventories in and export of biogenic carbon from the Labrador Sea, provide a description of plankton life-cycles and productivity in the Labrador Sea and its influence on ecosystems downstream, map the relative abundance and distribution of pelagic birds to monitor trends in their abundance and distribution in Atlantic Canada, extend the long time series of near-bottom temperature and currents on the slope off Hamilton Bank in the Labrador Sea by recovering and resetting a current meter mooring, deploy three moorings in the Gully region and support the international Argo network by deploying profiling drifting floats in the Labrador Sea and on the Halifax Line. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated throughout the cruise.

Next was a cruise to the Minas Basin at the head of the Bay of Fundy (Ed Horne/Brent Law, BIO) (Cruise 2013-013). This was run in collaboration with Dalhousie, Acadia and Queens universities. The purpose was to make measurements of the hydrodynamics and sediment dynamics in the Minas Basin in support of the advancement of tidal power and to document baseline conditions. The results were to be used to parameterize and validate coupled hydrodynamic and sediment models and increase their predictive capacity in forecasting future environmental impacts of potential tidal power developments. An instrumented bottom-mounted tripod was placed in the Southern Bight for the duration of the cruise. Instrumentation included a current meter, digital floc camera, digital video camera, transmissometer, CTD, optical back-scatter sensor and a water transfer system capable of collecting filters to determine the mass of suspended particulate matter. Two bottom-mounted upward looking Acoustic Doppler Current Profilers (ADCPs) were also deployed at two separate locations to accurately measure currents. Nutrients, chlorophyll, dissolved oxygen, salinity, suspended particulate matter and carbon dioxide were measured in water samples collected at anchor stations at five different locations. Surface reflectance measurements to validate remote sensing data using satellites were made using a light meter buoy. Sediments were collected using Videograb and Slo-Corer for grain size analysis while the erodibility of the seabed was measured using Slo-Corer and a Gust microcosm erosion chamber. In addition, sediment-laden ice blocks were released to assess melt rates and observe drift using the Fast Rescue Craft (FRC), vertical plankton tows were made during low and high tide periods while moored, the macrofauna collected in grabs was analyzed and video imagery was used to create a map of benthic habitat, including at the FORCE (Fundy Ocean Research Centre for Energy) site in the Minas Passage. On departing and returning to BIO, additional sampling was done at Station 2 on the Atlantic Zone Monitoring Program (AZMP) Halifax Line. A BBQ on the helicopter deck was held for all on the way home.

This was followed by a cruise to the Flemish Pass, Flemish Cap and Sackville Spur (Blair Greenan, BIO) (Cruise 2013-021). It involved participants from the Canadian Wildlife

Service (CWS) and Dalhousie. The primary objectives were to deploy three current meter moorings for one year in the Flemish Pass, collect CTD and Acoustic Doppler Current Profiler (ADCP) data at the mooring sites, use Campod to collect photographs and video of benthic habitat with a focus on sponges, collect sponges with Videograb for culturing studies, collect Hunttec DTS profiles on the northeastern margin of the Flemish Cap in support of the effort to extend the Canadian boundary under the United Nations Convention on the Law of the Sea (UNCLOS) and collect water samples for the analysis of methane and total inorganic carbon. Seabird, shark and marine mammal observations were also made. All objectives were achieved and the cruise terminated in St. John's, NL.

This was followed by a cruise to the Grand Banks, Sable Island Bank and the Gully which involved the participation of the National Research Council (Simon Courtney, BIO) (Cruise 2013-023). The purpose was to collect samples and perform studies on the natural attenuation capabilities of natural marine microbial communities in response to a potential crude oil or gas condensate spill off eastern Canada. Work was designed to evaluate whether natural microbial populations possess the ability to degrade petroleum hydrocarbons should they be accidentally spilled and to evaluate how cleanup techniques such as chemical dispersant application might affect this ability. This information will form a valuable part of any strategy to develop effective countermeasures for addressing potential petroleum spills off eastern Canada. Seawater samples were collected in close proximity to three hydrocarbon production platforms (Hibernia, Terra Nova and Thebaud) and used to set up a series of microcosm experiments to evaluate crude oil and gas condensate degradation rates. In addition, the samples were filtered to capture the bacteria and subjected to genomic analyses to determine which microorganisms are present and whether they possess hydrocarbon degradation ability. Genomic analyses were also performed on microcosms after a suitable incubation period to evaluate how microbial populations have changed in relation to the addition of oil, dispersant and nutrients. These genomic analyses will help determine which conditions have had the most beneficial effects on microbial petroleum degradation ability and will provide information on how to enhance natural hydrocarbon degradation rates. In addition, sea water and sediment samples from sites around the three production platforms were collected to determine baseline natural microbial populations and their properties in relation to location and depth. Observations on bacterial populations in seawater were also made in the deepest region of the Gully. The program was interrupted briefly by the need to transfer a crew member to the *Earl Grey* because of a family emergency. Despite this all objectives were achieved.

Next was a geological cruise to Hatton Basin at the mouth of Hudson Strait and Baffin Bay (Calvin Campbell, BIO) which was broken into two legs with a crew change in Nain, NL (Cruise 2013-029). In addition, two stops were made in Qikiqtarjuaq, NU to pick up and discharge Nunavut participants. The major objective was to improve understanding of the surficial geology, seafloor properties and processes on the continental shelf and slope to better assess geological hazards. A secondary objective was to improve understanding of benthic habitat in Baffin Bay. More specifically, the regional surficial geology was assessed, estimates were improved of the recurrence of large earthquakes in

the area through strategic coring in locations that might record an earthquake signature in the sediments, investigate natural hydrocarbon seeps, investigate slope instability features and investigate benthic habitat and organisms. Equipment used included a pole-mounted multibeam sounding system, sidescan sonar, piston core, IKU grab, van Veen grab, box corer, bottom camera, Campod and Videograb. During the cruise, *Hudson* reached the latitude of 74° N, the furthest north she had been for several years.

This was followed by a cruise to the Scotian Shelf, Scotian Slope and Cabot Strait which also involved participants from the Canadian Wildlife Service (CWS) and Dalhousie (Andrew Cogswell, BIO) (Cruise 2013-037). It was divided into two legs with a crew and staff change partway through in North Sydney, NS. The major objective was to carry out the annual fall sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). Other objectives included recovering deep water moorings at the seaward end of the Halifax Line in support of the UK RAPID-WAVE program, recovering and redeploying three Ocean Tracking Network (OTN) moorings along the Halifax Line, deploying a Carioca buoy along the Halifax Line to measure surface temperature, salinity, chlorophyll and pCO₂ at hourly intervals, recovering an autonomous multi-channel acoustic recorder from the Gully MPA in support of the SPERA project investigating bottlenose whale migration patterns, recovering two moorings on St. Ann's Bank deployed in support of the Health of the Oceans Initiative, conducting physical, chemical and biological sampling in the Gully in support of monitoring initiatives, conducting water column sampling on Roseway Bank near an area known for a seasonally high abundance of the endangered North Atlantic Right Whale which has been declared by the International Maritime Organization (IMO) as an area to be avoided, conducting water column sampling in the Gulf of Maine in support of the Gulf of Maine North Atlantic Time Series Program (GNATS) and deployment of four additional Argo floats. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise plus the Moving Vessel Profiler (MVP) collected CTD, fluorometer and Laser Optical Plankton Counter (LOPC) data along certain sections. Seabird and marine mammal observations were also made.

The next cruise was to the Gulf of St. Lawrence and St. Lawrence Estuary which was divided into two legs with a staff change in Gaspé, QC (Pierre Joly/ François Villeneuve, IML) (Cruise 2013-038). Personnel from the Canadian Wildlife Service participated. The main objective of the first leg was to estimate the spatial representativeness of the Atlantic Zone Monitoring Program (AZMP) transects in describing the abundance and biomass of key zooplankton species in the northern Gulf. The main objective of the second leg was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, phytoplankton and zooplankton. Seabird surveys were also conducted. The cruise ended at BIO.

Next was a cruise to the Scotian Shelf (Hilary Moors-Murphy, BIO) (Cruise 2013-040). Personal from the Canadian Wildlife Service (CWS) also participated. The main purpose was to continue the long-term acoustic monitoring project of whales using passive acoustic monitoring (PAM) equipment. Numerous moorings were deployed. Specific objectives included continuing studies in support of the northern bottlenose whale recovery strategy to determine areas of critical habitat, monitor the presence and abundance of other cetaceans including both toothed and baleen whales on the shelf edge, characterize the year-round acoustic environment of the Gully MPA and adjacent slope region and contribute to the development of PAM technologies for whale research. Seabird surveys were also conducted. The cruise ended in St. John's, NL.

The following cruise, the last of the year, was to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2013-042). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects were now Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank, St. Pierre and the new Station 27 lines. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. In addition, Acoustic Doppler Current Profiler (ADCP) data were collected while underway, four acoustic hydrophones were recovered and eight deployed in Hawke Channel off Labrador for tracking cod, and seabird surveys were carried out. Water samples for microcosm experiments were also collected in the vicinity of oil production platforms. The cruise ended in St. John's, NL.



Available cruise stations/tracks for 2013

2014

This year marked the publication of *Voyage of Discovery, Fifty Years of Marine Research at Canada's Bedford Institute of Oceanography*, a special volume commemorating the 50th anniversary of BIO. A painting of *Hudson* graced the cover and many of the chapters reviewed research carried out on *Hudson*.

Cruises

Captains: Rick Cotie/D. McEwan/Dave Martin

Number of Cruises: 7

Days at Sea: 141

Nautical Miles Steamed (Estimated): 22,419

The first cruise of the year was to the Scotian Shelf, Scotian Slope, Cabot Strait, Laurentian Channel and Northeast Channel which involved participants from the Canadian Wildlife Service (CWS) and Dalhousie (Andrew Cogswell, BIO) (Cruise 2014-004). It was divided into two legs with a staff change partway through at BIO. The major objective was to carry out the annual spring sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). Other objectives included recovering and redeploying three Ocean Tracking Network (OTN) moorings along the Halifax Line, recovering four autonomous multi-channel acoustic recorders between the Gully MPA and Haldimand Canyon in support of the SPERA project investigating bottlenose whale migration patterns, deploying two moorings on St. Ann's Bank deployed in support of the Health of the Oceans Initiative, collecting hydrographic and nutrient data across the Northeast Channel as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) cooperative agreement, conducting physical, chemical and biological sampling in the Gully in support of monitoring initiatives, conducting physical, chemical and biological sampling across the mouth of the Laurentian Channel in support of modelling initiatives, conducting further water column sampling on Roseway Bank near an area known for a seasonally high abundance of the endangered North Atlantic Right Whale which has been declared by the International Maritime Organization (IMO) as an area to be avoided, deployment of four additional Argo floats and collection of water samples near the Thebaud Platform and on St. Pierre Bank for biodegradation studies of naturally and chemically dispersed crude oil. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise plus the Moving Vessel Profiler (MVP) collected CTD, fluorometer and Laser Optical Plankton Counter (LOPC) data along certain sections. Seabird and marine mammal observations were also made. Heavy ice conditions in Cabot Strait at the start of the cruise dictated some last minute adjustments to the sequence of operations but overall the cruise was very successful with most objectives being met.

The next cruise was to Scotian Shelf, northwest Atlantic and Labrador Sea (Igor Yashayaev, BIO) (Cruise 2014-007). Participants from the Canadian Wildlife Service (CWS), Dalhousie, Laval, University of California, University of Montreal, University of

Ottawa and the University of Quebec were involved. There were numerous diverse objectives. The cruise continued the annual series of measurements in the Labrador Sea which began in 1990 as a contribution to the World Climate Research Program and has evolved in a multidisciplinary regional monitoring effort in order to better understand interannual and long-term changes of physical, chemical and biological properties and processes. The AR7W Line from Labrador to Greenland was sampled as usual. However, the two inshore stations near the Labrador coast had to be abandoned because of heavy ice conditions. Two current meter moorings were recovered and redeployed in slope water off Labrador. Autonomous floats were deployed as part of the international Argo program. The extended Halifax Line was sampled in support of Atlantic Zone Off-Shelf Monitoring Program (AZOMP). In so doing, the same Gulf Stream meander was crossed three times and it was possible to sample Antarctic Bottom water. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated during the entire cruise. The cruise was most successful and no major problems were encountered.

This was followed by a cruise to the Gulf of St. Lawrence (Yves Gagnon, IML) (Cruise 2014-035). Departing from the Institut Maurice-Lamontagne (IML) the main purpose was to carry out the standard spring Atlantic Zone Monitoring Program (AZMP) sampling usually done on *Teleost*. Other work included deployment of moorings, zooplankton studies and seabird observations.

Next was a cruise to the Labrador Sea, Flemish Cap and Logan Canyon which also involved the Canadian Wildlife Service (CWS), Memorial and McGill (Blair Greenan, BIO) (Cruise 2014-017). The major objectives were to deploy five current meter and CTD moorings at three sites on the Labrador slope as part of the US-led international Overturning of the Subpolar North Atlantic Program (OSNAP) designed to measure full-water column fluxes of heat, mass and freshwater, collect CTD and Acoustic Doppler Current Profiler (ADCP) data along the OSNAP 53N Line, recover three current meter moorings in the Flemish Pass deployed in 2013, collect CTD and Acoustic Doppler Current Profiler (ADCP) data in the Flemish Pass and deploy three passive acoustic monitoring moorings in Logan Canyon and the Gully to collect acoustic data during the seismic survey program to be carried out for British Petroleum along the eastern Scotian Slope. In addition, three ocean gliders were successfully deployed for Memorial and McGill universities. Seabird observations were also made.

The next cruise was to the Scotian Shelf, Scotian Slope, Cabot Strait and Northeast Channel (Dave Hebert, BIO) (Cruise 2014-030). It was divided into two legs with a crew and staff change partway through at BIO. The Canadian Wildlife Service (CWS), Dalhousie and the UK National Oceanography Centre participated. The primary objective was to carry out the annual fall sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). There were many other objectives as well. These included recovering and redeploying three Ocean Tracking Network (OTN) moorings at inner shelf stations along the Halifax Line, recovering and deploying deep water moorings in slope water at the seaward end of the Halifax Line in support of the UK RAPID-WAVE program, deploying and recovering a Seahorse mooring along the Halifax Line,

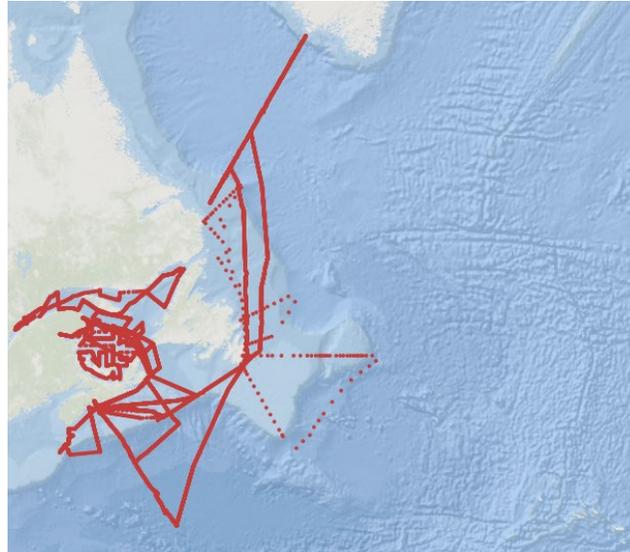
recovering six autonomous multi-channel acoustic recorders in slope water in support of the SPERA project investigating bottlenose whale migration patterns, conducting physical, chemical and biological sampling in the Gully in support of monitoring initiatives, recover and redeploy moorings on St. Ann's Bank deployed in support of the Health of the Oceans Initiative, conducting water column sampling on Roseway Bank near an area known for a seasonally high abundance of the endangered North Atlantic Right Whale and deploying nine additional Argo floats. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise. Seabird and marine mammal observations were also made. Despite some weather related delays and ship issues, most of the objectives were met.

Next was the annual fall cruise to the Gulf of St. Lawrence and St. Lawrence Estuary for the Quebec Region which was broken up into two legs (Cruise 2014-033). Departing from BIO, the objectives of the first leg (Pierre Joly, IML) were to estimate the spatial arrangement of the Atlantic Zone Monitoring Program (AZMP) transects for describing the abundance and biomass of key zooplankton species, sample larval and juvenile krill using a jack-net equipped with a strobe light to elaborate a recruitment index in the Gulf of St. Lawrence, collect water samples for chlorophyll and dissolved oxygen measurement and conduct experiments on the physiological condition of krill. The passage of Hurricane Gonzalo through the area caused some bad weather and only half of the planned work could be completed. Partway through there was a personnel exchange at Gaspé, QC where the leg later ended.

Departing from Gaspé, the objectives of the second leg (François Villeneuve, IML) were to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, phytoplankton and zooplankton. pH, alkalinity and pCO₂ were now also measured to estimate the state of acidification in the Gulf and Estuary. Larval and juvenile krill were again sampled using a jack-net equipped with a strobe light to develop a recruitment index for the Gulf, suspended particulate matter (SPM) was measured, three moorings were deployed to collect physical data in relation with lobster fisheries, an instrumented mooring was deployed in the Old Harry region and seabird surveys were conducted. All objectives were achieved and the cruise ended at BIO.

Hudson then steamed to St. John's, NL for the next cruise to the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2014-034). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects sampled were the Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank and Station 27 lines. The usual physical, chemical and biological variables were measured using a CTD Rosette and zooplankton were collected using vertical plankton nets. New variables measured starting this year were pH, photosynthetic active radiation (PAR) and particulate organic carbon and nitrogen. In addition, Acoustic Doppler Current Profiler (ADCP) data were collected while underway.

Acoustic hydrophones moorings used for cod tracking were recovered in Hawke Channel and along the Bonavista line. Two oceanographic moorings were deployed in support of a new observing system as part of an international program entitled Overturning in the Subpolar North Atlantic Program (OSNAP). Experiments were conducted using FlowCAM technology for quantitative image analysis of large phytoplankton and mesozooplankton. Seawater samples were collected at 43 stations along all the transects for analysis of pH, total inorganic carbon and carbon dioxide in order to assess the state of calcium carbonate saturation and ocean acidification. The distribution and abundance of seabirds were also observed and recorded. The cruise ended in St. John's, NL.



Available cruise stations/tracks for 2014

2015

Cruises

Captains: Darrel London/Catherine Lacombe/Paul Bragg/ Dave Martin/James Strickland

Number of Cruises: 7

Days at Sea: 130

Nautical Miles Steamed (Estimated): 20,670

The first cruise of the year was to the Scotian Shelf, Scotian Slope and Northeast Channel which involved participants from the Canadian Wildlife Service (CWS) and Dalhousie (Andrew Cogswell, BIO) (Cruise 2015-004). The major objective was to carry out the spring sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP). However, the original sailing date was postponed 10 days due to delays in the winter refit and personnel issues and, as a result, quite a few of the additional planned objectives had to be cancelled. These were either postponed to later cruises or moved to other vessels. Also, due to heavy ice conditions, sampling on the Cabot Strait Line had to be cancelled at the last minute. However, those additional objectives carried out included

physical, chemical and biological sampling in the Gully in support of monitoring initiatives, further water column sampling on Roseway Bank near the area known for a seasonally high abundance of the endangered North Atlantic Right Whale, deployment of four Argo floats, studies of ocean acidification and calcium carbonate saturation state and studies of the non-breeding season diet of dovekies. Seabird and marine mammal observations were also made.

The next cruise was to the Scotian Shelf, Scotian Slope, Labrador Sea and Laurentian Channel (Igor Yashayaev, BIO) (Cruise 2015-006). Participants from the Canadian Wildlife Service (CWS), Dalhousie, University of South Carolina, Georgia Institute of Technology, Laval, University of Quebec, University of Montreal and University of Victoria were involved. There were numerous diverse objectives and these included some that were postponed from the previous cruise. The cruise continued the annual series of measurements in the Labrador Sea which began in 1990 as a contribution to the World Climate Research Program and has evolved into a multidisciplinary regional monitoring effort in order to better understand interannual and long-term changes of physical, chemical and biological properties and processes. The AR7W Line from Labrador to Greenland was sampled as usual. Sampling was done in support of the Atlantic Zone Monitoring Program (AZMP) and the Atlantic Zone Off-Shelf Monitoring Program (AZOMP). Additional objectives were to contribute to the monitoring goals of the Global Ocean Observing System and the Global Climate Observing System and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program, provide a description of the inventories and export of biogenic carbon from the Labrador Sea and of plankton life cycles and productivity in the Labrador Sea and its influence on ecosystems downstream, map the distribution and abundance of seabirds, extend the long time series of near bottom temperature and currents on the slope of Hamilton Bank by recovering and resetting a current meter mooring, redeploing three moorings in support of the international OSNAP program, deploying six moorings in support of the Atlantic Zone Monitoring Program (AZMP) program and supporting the international Argo program by deploying additional profiling drifting floats in the Labrador Sea and along the Halifax Line. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was operated during the entire cruise. The cruise was most successful and no major problems were encountered.

Next was a cruise to the Scotian Shelf, Laurentian Channel and the Grand Banks for more benthic surveys (Ellen Kenchington, BIO) (Cruise 2015-011). Included were scientists from the World Wildlife Fund (WWF) and Dalhousie University. The main purpose was to collect high-resolution digital imagery (both video and stills) using the 4K Camera System, the DeepImager System, CTD data, water samples and sediment samples to characterize vulnerable marine ecosystems (VMEs) and ecologically and biologically significant areas (EBSAs). Specific sites sampled included the Stone Fence, Tail of the Grand Bank, Southeast Shoal, Newfoundland Seamounts, Flemish Cap, Laurentian Channel and St. Ann's Bank. The data collected on this cruise were used to ground-truth models identifying significant concentrations of vulnerable marine ecosystem indicator species and to assess benthic biodiversity, particularly in the Newfoundland area of

interest. Not all the planned work could be completed because of bad weather and responding to two search and rescue calls.

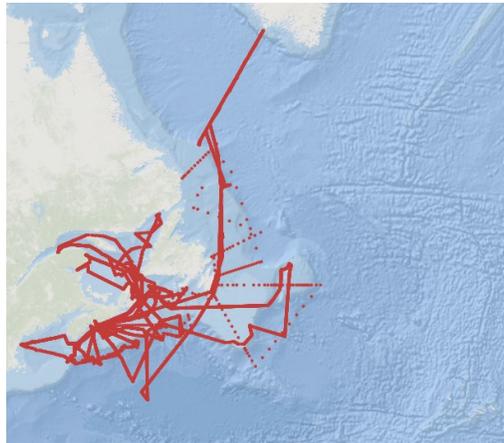
Next was a geological cruise to the continental slope off Nova Scotia (Calvin Campbell, BIO) (Cruise 2015-018) which included participants from Geoforce, the University of Calgary, Environment Canada and the Nova Scotia Department of Energy (NSDE). This was the first cruise of a new joint research project undertaken with NSDE to investigate and sample seabed hydrocarbon seep features along the continental slope off Nova Scotia. These are common features in petroleum basins around the world and can provide critical information on hydrocarbon sources, migration pathways and maturity. However, these are notoriously difficult to sample because of their ephemeral nature and environmental complexities. A multidisciplinary approach was used to select the most appropriate areas for sampling the seabed. This included utilizing all available seismic reflection data, interpreting sea-surface hydrocarbon slick occurrences imaged in satellite data and near real-time assessment of seabed and water column anomalies using a multibeam echo sounder and high-resolution seismic reflection systems. Equipment used included the Huntec DTS, multibeam bathymetric sounder and piston corer. Cores were collected at 22 stations and were processed on board and subsampled for conventional organic geochemical and geomicrobiological analysis. Besides understanding the petroleum system, the core samples served other important research needs including improved understanding of sediment microbiology and geological hazard assessment.

This was followed by a cruise to the Scotian Shelf, Scotian Slope, Cabot Strait, Laurentian Channel, Northeast Channel and the Gulf of Maine (Dave Hebert, BIO) (Cruise 2015-030). It was divided into two legs with a staff change partway through in Sydney, NS. The Canadian Wildlife Service (CWS) and Dalhousie University participated. The primary objective was to carry out the annual fall sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) in the Maritimes Region. Other objectives included deploying an autonomous multi-channel acoustic recorder at the Stone Fence to investigate whale migration patterns, collecting physical, chemical and biological data in the Gully in support of monitoring initiatives, deploying five Acoustic Doppler Current Profiler (ADCP)/Microcat moorings on St. Ann's Bank, collecting physical and nutrient data across the Northeast Channel as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) program, collecting physical, chemical and biological data at the mouth of the Laurentian Channel in support of modelling studies, conducting water column sampling on Roseway Bank near an area known for a seasonally high abundance of the endangered North Atlantic Right Whale, collecting water column data across the Gulf of Maine, deployment of eight additional Argo profiling floats, collecting further information on ocean acidity and calcium carbonate saturation and further studies investigating the non-breeding season diet of dovekies. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise. Seabird and marine mammal observations were also made. The cruise was most successful.

Next was a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary (Caroline Lafleur, IML) which departed from Gaspé, QC (Cruise 2015-033). The objectives were

to carry out the fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, phytoplankton and zooplankton, pH, alkalinity, pCO₂, turbidity, suspended particulate matter and photosynthetic active radiation (PAR). In addition, various instrumented moorings were recovered and redeployed, studies of krill eggs and larvae continued and seabird recruitment was investigated. Partway through a stop was made in Sydney, NS to have the ship's gyro repaired and replace a sick crew member. Soon after, *Hudson* had to return to BIO briefly to have a lifeboat tested. Unfortunately only about one half of the objectives were achieved. The cruise terminated in Gaspé, QC.

Hudson then steamed to St. John's for the last cruise of the year to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2015-035). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects sampled were the Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank, Station 27 and St. Pierre Bank lines. The usual physical, chemical and biological variables were measured using a CTD Rosette. These now included pH, photosynthetic active radiation (PAR) and particulate organic carbon and nitrogen. Zooplankton were collected using vertical plankton nets. Acoustic Doppler Current Profiler (ADCP) data were collected while underway along the transects and expendable bathythermographs (XBTs) were released between transects. Two oceanographic moorings were recovered, refurbished and redeployed in support of the international Overturning in the Subpolar North Atlantic Program (OSNAP). Two additional oceanographic moorings were recovered, refurbished and redeployed in the Laurentian Channel Area of Interest (AOI) which was being considered as a potential Marine Protected Area (MPA). Four profiling floats were released off St. Pierre Bank and the southern Grand Bank in support of the international Argo program and eleven Surface Velocity Profilers (SVP) satellite drifters were deployed on Hamilton Bank to support numerical modeling validation and verification and the improvement of ocean prediction systems. Further experiments were conducted using FlowCAM technology for quantitative image analysis of large phytoplankton and mesozooplankton. The distribution and abundance of seabirds were also observed and recorded. The cruise ended in St. John's, NL.



Available cruise stations/tracks for 2015

2016

Cruises

Captains: Rick Cottie/James Strickland/Dave Martin/ Catherine Lacombe

Number of Cruises: 7

Days at Sea: 167

Nautical Miles Steamed (Estimated): 26,553

The first cruise of the year was to the Scotian Shelf, Scotian Slope and Northeast Channel (Dave Hebert, BIO) (Cruise 2016-003). It was divided into two legs with a staff change partway through at BIO. The Canadian Wildlife Service (CWS) and Dalhousie University participated. The primary objective was to carry out the annual spring sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and the Atlantic Zone Off-Shelf Monitoring Program (AZOMP). Some of the other planned objectives had to be cancelled due to weather or lack of time. Also, due to crane problems which could not be corrected before sailing, no mooring deployments could be undertaken during the cruise. However, other objectives successfully carried out included recovering five autonomous multi-channel acoustic recorders investigating whale migration patterns, collecting physical, chemical and biological data in the Gully in support of monitoring initiatives, collecting physical and nutrient data across the Northeast Channel as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) program, conducting water column sampling on Roseway Bank near the area known for a seasonally high abundance of endangered North Atlantic Right Whales, deployment of two additional Argo profiling floats, collecting further information on ocean acidity and calcium carbonate saturation, further studies investigating the non-breeding season diet of dovekeys and recovery and redeployment of four moorings in slope water on the Halifax Line in support of the RAPID-WATCH program. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise. Seabird and marine mammal observations were also made.

The next cruise was to the Scotian Shelf, Cabot Strait and Labrador Sea (Igor Yashayev, BIO) which departed from and returned to BIO (Cruise 2016-006). There were numerous visiting scientists from the University of Quebec, Laval, University of Montreal, University of Victoria and the Georgia Institute of Technology. The many objectives were to collect physical, chemical, and biological field data to detect and measure interannual variability in ecosystems of the Atlantic Canadian shelves and slopes, provide a description of the interannual variations in physical, chemical, and biological properties along the AR7W Line across the Labrador Sea in support of the Atlantic Zone Off-shore Monitoring Program (AZOMP) and on the Halifax Line and related offshore stations in support of the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-shore Monitoring Program (AZOMP), contribute to the monitoring goals of the Global Ocean Observing System and the Global Climate Observing System and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program, provide a description of the inventories and export of biogenic carbon from the Labrador Sea, provide a description of plankton life-cycles and productivity in the Labrador Sea and its influence on ecosystems downstream, map the relative abundance and distribution of pelagic birds to monitor trends in abundance and distribution, extend a long time series of near-bottom temperature and currents on the slope off Hamilton Bank in the Labrador Sea by recovering and resetting a current meter mooring, redeploy one mooring as a part of collaboration with VITALS, three moorings in support of the international OSNAP program and deploy six moorings in support of the Atlantic Zone Monitoring Program (AZMP) program, and support the international Argo network and international surface drifter program by deploying profiling drifting floats in the Labrador Sea and on the Halifax Line. Expendable bathythermographs (XBTs) were launched underway between selected stations. In addition, the scientific seawater sampling system in the forward laboratory and the ship-mounted Acoustic Doppler Current Profiler (ADCP) were operated throughout the cruise.

Next was another geological cruise to the Scotian Slope (Calvin Campbell, BIO) (Cruise 2016-011) which was broken into two legs. This region on the outer margin of Nova Scotia, off Banquereau, Emerald, LaHave and Browns banks, is highly incised by submarine canyons and contains numerous slide scars and mass transport deposits. The prime purpose of the first leg was to acquire additional geological data to improve understanding of the recurrence of large submarine landslides and turbidity currents during the late Quaternary. Additionally, this information will greatly improve understanding of sedimentary processes along the offshore margin of Nova Scotia in support of Canada's submission to the United Nations Convention on the Law of the Seas (UNCLOS) for defining territorial boundaries. Specific objectives included carrying out high-resolution seismic surveys perpendicular to the outer slope, collecting sediment cores to confirm the nature of the sediments imaged by seismic surveys, measuring the recurrence of sediment transport events during the late- Quaternary along deep-water submarine channels, evaluating the recurrence rates of large submarine landslides and their significance in terms of geohazards and assessing the stability of Nova Scotia's outer slope. Data collected included 2,616 km of 3.5 kHz sub-bottom profiles, 480 km of GI gun seismic profiles and 569 km of Hunttec DTS seismic profiles. The objectives of

the second leg, which included participants from the University of Calgary, were generally the same as the first but also included the goal of sampling as many potential cold seeps as possible. Airgun, the Huntec DTS seismic reflection and Knudsen sub-bottom profiler systems were used for surveys. A piston corer, box corer and a slick sampler were used to collect samples at 50 stations. Most of the areas selected for sampling were located near the crest of buried salt structures where faults appeared to approach the seabed. Oil sheens, degassing hydrate clasts and strong sulfur smells indicating seepage were evident in several sediment cores.

This was followed by a major cruise to various locations between Nova Scotia and Bermuda (Ellen Kenchington, BIO) (Cruise 2016-019). This multidisciplinary, international scientific cruise was sponsored by the Nekton Foundation in collaboration with Oxford University and the Bermuda Institute of Ocean Science (BIOS). Because of the nature of the cruise, a large number of non-BIO participants were involved. These were associated with DSSI (Deep Sea Systems International), the Nekton Foundation, the University of Bergen and Heriot-Watt University. The overall goal was to establish what healthy, unaltered marine ecosystems look like today in order to judge the effects of future climate change or other anthropogenic impacts. The mechanism for doing this was the newly developed protocol for a rapid ocean health assessment called Ocean Health Check (OHC) which will produce a baseline report on specific chemical, physical and biological parameters of the North Atlantic between Bermuda and Halifax. Sampling equipment included a remotely operated vehicle (ROV), the Moving Vessel Profiler (MVP), CTD Rosette, ring nets, XBTs, box corer and a multibeam echo sounder. Benthic and pelagic sampling was conducted at multiple stations within several deep-water canyons on the Scotian Slope, on seamounts in the New England seamount chain and in deep waters off Bermuda. To assess the state of the benthic ecosystem, the ROV was used to collect high-resolution benthic imagery and specimen samples to provide data on how the distribution of benthic organisms varies with changes in habitat. In addition, ring nets were used to ensure that there was a full representation of water-borne taxa including zooplankton and micronekton from a range of depths. Sediment samples were collected using a van Veen grab and box corer. In addition, targeted hydrographic sampling was conducted within the Gulf Stream between Halifax and Bermuda where ocean chemistry and the biota associated with the cold wall of the Gulf Stream were examined to determine whether these cold walls are major centres for ecological interactions. In Bermudian waters, the work focused on ROV and multibeam data collection. A port call was made in St. George's to exchange personnel.

Next was a cruise to the Scotian Shelf, Scotian Slope, Cabot Strait, Northeast Channel and Gulf of Maine (Andrew Cogswell, BIO) (Cruise 2016-027). It was divided into two legs with a staff change partway through in Sydney, NS. The Canadian Wildlife Service (CWS) and Dalhousie University participated. The primary objective was to carry out the fall sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). Other objectives included recovering one and deploying five autonomous multi-channel acoustic recorders investigating whale migration patterns, recovering and deploying a mooring in Emerald Basin to measure the magnitude and dynamics of the Nova Scotia Current, deploying and

recovering six moorings on St. Ann's Bank, collecting physical, chemical and biological data in the Gully in support of monitoring initiatives, conducting water column sampling on Roseway Bank near the area known for a seasonally high abundance of endangered North Atlantic Right Whales, collecting physical, chemical and biological data across the Gulf of Maine as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) program, deploying eight Argo profiling floats, collecting further information on ocean acidity and calcium carbonate saturation and further studies investigating the non-breeding season diet of dovekeys. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise. Seabird and marine mammal observations were also made. Most of the objectives were fully achieved.

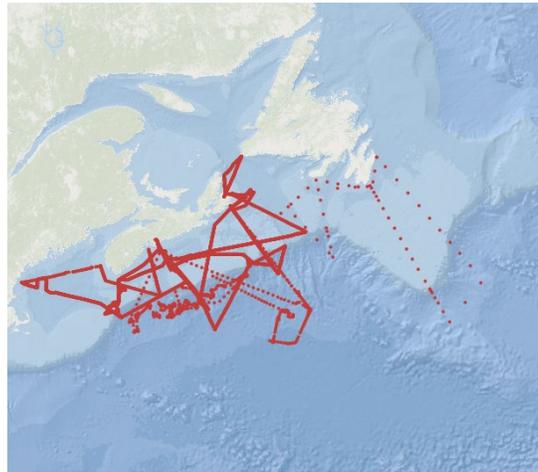
Next was a cruise to the Gulf of St. Lawrence, the St. Lawrence Estuary and Saguenay Fjord which began at Gaspé, QC and was divided into two legs (Cruise 2016-031). The main objective of the first leg (Michael Scarratt, IML) was to sample a grid of stations in the St. Lawrence Estuary and Saguenay Fjord to study phenomena related to estuarine eutrophication. CTD data were collected as well as water samples for the determination of particulate organic carbon (POC), chlorophyll, nutrients, dissolved oxygen, salinity, pH, alkalinity, N₂O, phytoplankton, transparent exopolymer particles and methane. In addition, scientific moorings were recovered for service and redeployment during the second leg. Studies of seabird abundance, distribution and recruitment were also carried out.

The prime purpose of the second leg (François Villeneuve, IML) was to carry out the fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, N₂O, methane, phytoplankton and zooplankton, pH, alkalinity, pCO₂, turbidity, suspended particulate matter and photosynthetic active radiation (PAR). In addition, three moorings were deployed and another was recovered and further studies of seabird recruitment were conducted. The cruise ended in Gaspé, QC. All standard sections were successfully sampled.

Hudson then steamed to St. John's, NL for the last cruise of the year to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Eugene Colbourne, NAFC) (Cruise 2016-034). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects sampled were the Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank, Station 27 and St. Pierre Bank lines. The usual physical, chemical and biological variables were measured using a CTD Rosette. These now included pH, photosynthetic active radiation (PAR) and particulate organic carbon and nitrogen. Zooplankton were collected using vertical plankton nets. Acoustic Doppler Current Profiler (ADCP) data were collected while underway along and between transects. Two oceanographic moorings were recovered, refurbished and redeployed in support of the international Overturning in the Subpolar

North Atlantic Program (OSNAP), as well as the Station 27 mooring. Two additional oceanographic moorings were recovered, refurbished and redeployed in the Laurentian Channel Area of Interest (AOI). Three profiling floats were released off the southern Grand Bank in support of the international Argo program. Seawater samples were collected along the transects for the determination of calcium carbonate saturation and ocean acidification states. The distribution and abundance of seabirds were also observed and recorded. The cruise ended in St. John's, NL.

In December, just before the St. Lawrence Seaway was closed for the winter, *Hudson* sailed to Hamilton, Ontario for a lengthy refit at Heddle Shipyards.



Available cruise stations/tracks for 2016

2017

The 4,364 km² St. Ann's Bank Marine Protected Area (MPA) was created.

The refit work was supposed to be completed by May and five cruises were scheduled after *Hudson* returned to BIO. Unfortunately, many problems were encountered with the refit and the work fell far behind schedule. As a result, other vessels had to be chartered to carry out essential programs. In October, it was clear that the refit at Heddle Shipyards would not be completed as planned before freeze up. Therefore, the decision was made to tow *Hudson* to the nearby federal Canada Centre for Inland Waters (CCIW) in Burlington where work continued. Then, just before freeze up, she returned to BIO through the seaway to complete the refit alongside over the winter. As a result of this fiasco, there were no *Hudson* cruises this year.

The Coast Guard vessel *Martha L. Black* was used for some cruises usually carried out on *Hudson*. In addition, the *Coriolis II* was chartered for the Atlantic Zone Monitoring Program (AZMP) cruises. She was a Canadian research vessel, previously belonging to the Coast Guard, based in Rimouski QC and operated by a consortium of five Quebec institutions, including the Institut Maurice-Lamontagne (IML).

2018

The Sable Offshore Energy Project (SOEP) was decommissioned after just nineteen years of production.

Hudson continued her refit over the winter at BIO and work included modifications to cabins and laboratories.

Cruises

Captain: Rick Cotie/Fergus Francey/Dave Martin

Number of Cruises: 9

Days at Sea: 183

Nautical Miles Steamed (Estimated): 29,097

Departing in April, the first cruise of the year was to the Scotian Shelf, Scotian Slope, Cabot Strait, Laurentian Channel, Northeast Channel and Gulf of Maine (Andrew Cogswell, BIO) (Cruise 2018-004). Partway through, an emergency visit was made to Sydney, NS to repair a leaky scupper which had caused flooding in the senior engineer's cabin. The Canadian Wildlife Service (CWS) and Dalhousie again participated. The primary objective was to carry out the annual spring sampling along the standard lines for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP). Other objectives included collecting physical, chemical and biological data in the Gully in support of monitoring initiatives, collecting physical, chemical and biological data across the Northeast Channel and Gulf of Maine as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) program, deploying more Argo profiling floats, collecting further information on ocean acidity and calcium carbonate saturation and collecting physical, chemical and biological data in the newly established St. Ann's Bank MPA, on St. Pierre Bank and across the mouth of the Laurentian Channel. The ship-mounted Acoustic Doppler Current Profiler (ADCP) was in operation for the entire cruise. Seabird and marine mammal observations were also made. Most of the objectives were fully achieved. The cruise terminated in Sydney, NS.

Next was a cruise to the Scotian Shelf, Cabot Strait and Labrador Sea (Igor Yashayev, BIO) which departed from Mulgrave, NS (Cruise 2018-008). Included were participants from the University of Quebec and Edinburgh University. The many objectives were to collect physical, chemical, and biological field data to detect and measure interannual variability in ecosystems of the Atlantic Canadian shelves and slopes, provide a description of the interannual variations in physical, chemical, and biological properties along the AR7W Line across the Labrador Sea in support of the Atlantic Zone Off-Shelf Monitoring Program (AZOMP) and on the Halifax Line and related offshore stations in support of the AZOMP, contribute to the monitoring goals of the Global Ocean Observing System and the Global Climate Observing System and the research activities of the Climate Variability and Predictability (CLIVAR) project of the World Climate Research Program, provide a description of the inventories in and export of biogenic

carbon from the Labrador Sea, provide a description of plankton life-cycles and productivity in the Labrador Sea and its influence on ecosystems downstream, map the relative abundance and distribution of pelagic birds to monitor trends in their abundance and distribution in Atlantic Canada, extend a long time series of deep temperature, salinity and currents on the Labrador Slope off Hamilton Bank and in the Deep Western Boundary Current off Nova Scotia by recovering and resetting current meter moorings, redeploy five moorings in support of the international OSNAP program and support the international network of profiling drifting Argo floats by deploying additional floats in the Labrador Sea and along the Halifax Line. Expendable bathythermographs (XBTs) were launched underway between selected stations. In addition, the scientific seawater sampling system in the forward laboratory and ship-mounted Acoustic Doppler Current Profiler (ADCP) were operated throughout the cruise which terminated back at BIO.

This was followed by a geological cruise to the Scotian Slope (Calvin Campbell, BIO) (Cruise 2018-041) to continue seeking evidence of cold seeps on the seafloor and the presence of gas hydrates. It was a joint cruise with the Nova Scotia Department of Energy and Mines which included participants from the University of Calgary and Saint Mary's University. Defence Research and Development Canada (DRDC) was also involved and operated an Autonomous Underwater Vehicle (AUV). The general objectives were to target several sites with the purpose of collecting high-resolution seabed imagery, using hull-mounted and towed instruments to collect geological information and collecting sediment samples in order to better understand cold seeps and sediment transport processes. Specific objectives included conducting high-resolution bathymetric, sidescan sonar and sub-bottom surveys using an AUV, collecting high-resolution video and photography where seabed seepage of fluids is observed, collecting high-resolution sparker reflection data and collecting long gravity core and box core samples for later analysis of geochemical, geomicrobiological, sedimentological and geotechnical properties. In addition, an Unmanned Aerial Vehicle (UAV) (i.e. drone) was deployed as a proof of concept for future field operations. During the cruise, 920 km of Huntec DTS sparker and 2,170 km of Knudsen 3.5 kHz sub-bottom profiler data were collected. In addition, three AUV surveys and six camera transects were conducted and 13 gravity cores and four box cores were collected. The large gravity corer worked well and provided a very efficient means to collect sediment samples. The AUV data provide unprecedented imagery of the seabed and shallow sub-surface. Deployment and recovery protocols for the AUV were improved with each deployment. The UAV proved feasible and will likely be a useful tool in the future for identification of sea-surface slicks.

This was followed by a cruise to the Scotian Shelf (Lindsey Beazley, BIO) which involved participants from Dalhousie University and the Netherlands Institute of Sea Research (NIOZ) (Cruise 2018-021). The overall goal was to collect data in support of three projects under the Program for Ecosystem-Based Research and Advice (SPERA). The primary gear used was Campod which had recently been refurbished to include a fibre-optic steel cable with high-resolution video capacity. The first work location was at the *Vazella* sponge grounds in Emerald Basin with the purpose of validating the modeled areas of sponge presence to ascertain whether the boundaries of closures adequately protect the distribution of this species. The second location was the proposed Eastern

Canyons Conservation Area located along the eastern Scotian Slope with the purpose of collecting data on the recoverability of the reef-building coral *Lophelia pertusa* in order to determine if the boundaries of the coral conservation area were adequate, collect further information on the distribution of deep-water corals in this region and to ascertain whether the boundaries of the proposed fishery management measures are properly placed. The third major work location was the Eastern Shore Islands Area of Interest (AOI) with the goal of collecting data to expand mapping of the benthic communities on the Scotian Shelf and provide advice on biological boundaries which could be used in Marine Protected Area (MPA) planning. Hydrographic data and water samples were also collected using a CTD Rosette.

This was followed by a cruise to the Laurentian Channel (Peter Lawton, SABS) (Cruise 2018-027). This was the third cruise of the Canadian Healthy Oceans Network (CHONe) program which involved both Memorial and Dalhousie and was organized in collaboration with the Maritimes and Newfoundland and Labrador Regions of DFO. The intent was to develop scientific survey approaches to address benthic ecology research and develop effective monitoring approaches for deep-water areas of conservation interest including Areas of Interest (AOIs) and Marine Protected Areas (MPAs). In addition, this cruise also supported the development of marine science in general in Canada due to a major focus on education and training of Canada's next generation of marine scientists in the conduct of policy-relevant science. It directly supported the research projects of three PhD students, one MSc student, and one postdoctoral fellow conducting scientific research on benthic habitats and benthic species associations in the Laurentian Channel. Georeferenced seabed imagery was collected using the latest version of Campod, sediment samples were collected with the Memorial Multicorer and a van Veen grab while water column sampling for physical and biological properties was done using a CTD Rosette and plankton ring nets. Partway through the cruise, an unscheduled visit was made to North Sydney, NS because of a family medical emergency and to duck a hurricane. In total, thirteen stations were successfully sampled before *Hudson* returned to BIO.

Next was a geological cruise to southern Baffin Bay (Alex Normandeau, BIO) (Cruise 2018-042). The purpose was to investigate marine geohazards and natural hydrocarbon seeps in fjords along the southeastern coast of Baffin Island. High resolution multibeam bathymetric and sub-bottom surveys were conducted over features of interest identified during previous expeditions, high resolution video and photographic surveys were collected over areas of suspected natural hydrocarbon seeps and piston core and box core samples were collected over a variety of targets. Numerous CTD Rosette and plankton net stations were also occupied. Work concentrated at Cape Dyer, Southwind Fjord and Home Bay. The navigation was quite challenging for the fjords were largely uncharted and therefore the Fast Rescue Craft (FRC) was used to take soundings before moving close inshore. Iceberg scours, potential pockmarks, evidence of active sediment transport and diverse biological communities were observed on the seafloor. Evidence of turbidites and underwater landslides was also widespread. No major problems were encountered and all cruise objectives were attained. Before leaving the area, the ashes of a former crew member were spread in Southwind Fjord. A return visit in 2019 on

Amunsden led to the discovery that an iceberg observed by *Hudson* had later flipped over and triggered an underwater landslide.

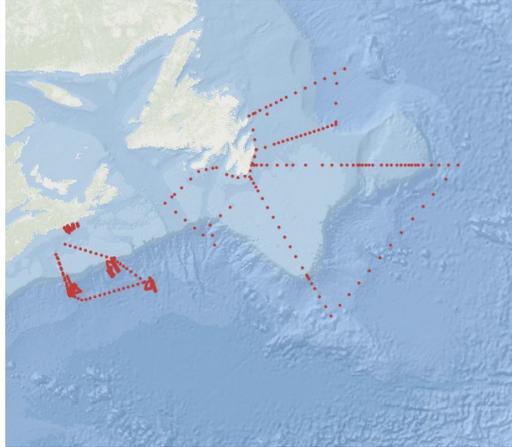
Next was a cruise to the Scotian Shelf and Slope which included participants from Dalhousie (Dave Hebert, BIO) (Cruise 2018-030). The primary objectives were to carry out the fall Atlantic Zone Monitoring Program (AZMP) sampling for the Maritimes Region and to service nine current meter moorings in the Nova Scotia Current. Additional objectives were to occupy stations in support of the extended Halifax Line, carry out hydrographic, chemical and biological sampling at stations in the Gully in support of Gully MPA monitoring initiatives, measure nutrients and hydrography across the Northeast Channel and Gulf of Maine as part of Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) Cooperative Agreement, deploy seven profiling floats in support of the international Argo program, collect water samples at specified locations and depths to fulfill the regional component of an Aquatic Climate Change Adaptation Services Program (ACCASP) initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic, collect water samples to evaluate whether and how organic and organometallic micronutrients influence primary productivity and phytoplankton community structure on the Scotian Shelf, collect water samples from strategic locations and depths to support a microbial community analysis via DNA, RNA and flow cytometry as well as the isolation of novel diazotrophs, make seabird observations in fulfillment of Gully and St. Ann's Bank MPA occupation requirements, carry out hydrographic, chemical and biological sampling in the St. Ann's Bank MPA as a continued monitoring effort, conduct hydrographic, chemical and biological sampling across the mouth of the Laurentian Channel and St. Pierre Bank to enhance understanding of hydrographic phenomenon in support of current modeling efforts, deploy and recover seven Autonomous Multi-channel Acoustic Recorders (AMARs) in support of projects investigating ambient and anthropogenic noise and the occurrence of North Atlantic right whales and other cetacean species on the Scotian Shelf, carryout stratified multi-net sampling of deep slope waters for the continuation of long term zooplankton monitoring efforts, underway testing of the FluoroSea system, test the SeaFET pH sensor in the underway system and carryout seabird and mammal observations. Partway through, the cruise a crew exchange was made at BIO. All these ambitious objectives were met.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary which was broken into two legs (Cruise 2018-038). The first leg (Geneviève Perrin, IML) included a large contingent from BIO. *Hudson* departed from BIO and steamed directly to Gaspé, QC by way of the Canso Causeway locks to pick up staff and equipment from the Institut Maurice-Lamontagne (IML) in Mont-Joli, QC. The major objective was to quantify variations in hydrography, ocean circulation, and concentration of zooplankton at fine-scales (0.1 – 1 km) and meso-scales (10-100 km) in the western Gulf where right whales had been recently observed. Zooplankton were sampled with a JackNet, BIONESS and the Video Plankton Recorder (VPR). Water properties were measured using a CTD Rosette and a vessel-mounted Acoustic Doppler Current Profiler (ADCP) was used to make continuous measurements of current velocity. Sampling was performed at fixed stations spaced 30-40 km apart and along two 4-5 km transects which

were sampled repeatedly over a 24 h period. In addition, systematic marine mammal surveys were carried out throughout the daylight hours both when in transit and on station. This was only the second time that drones were used on *Hudson*. After testing drone deployment protocols, they were used to collect imagery of whales. The abundance and distribution of seabirds were also recorded. This leg ended in Dalhousie, NB. Staff were very satisfied with the results of this leg.

The main objective of the second leg (David LeBlanc, IML) was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured along the standard sections using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, N₂O, methane, phytoplankton, zooplankton, pH, alkalinity, pCO₂, turbidity, suspended particulate matter and photosynthetic active radiation (PAR). In addition, five instrumented moorings were retrieved and redeployed, two surface buoys recovered and seabird recruitment studies were carried out. This leg was also most successful and ended at Gaspé, QC.

Hudson then steamed to St. John's, NL for the last cruise of the year to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Stephen Snook, NAFC) (Cruise 2018-035). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects sampled were the Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank, Station 27 and St. Pierre Bank lines. The usual physical, chemical and biological variables were measured using a CTD Rosette. Zooplankton for taxonomic and biochemical analyses were collected by vertical plankton net tows. Acoustic Doppler Current Profiler (ADCP) data were collected while underway along and between transects. Mooring work was done at Station 27 and a marine mammal mooring was recovered. Eight Argo floats were released in support of the international Argo program and two SVP drifters were also released. In addition, an underwater glider was used to enhance sampling frequency along the Bonavista Line. The distribution and abundance of seabirds were also observed and recorded. During this cruise, *Hudson* experienced a severe storm which did extensive damage in Newfoundland. While she was able to remain at sea and continue working, most other Coast Guard vessels sought shelter in port. The cruise ended in St. John's, NL.



Available cruise stations for 2018

2019

The new 11,580 km² Laurentian Channel Marine Protected Area (MPA) was established.

In February, *Hudson* sailed to St. John's, NL for another refit at the St. John's Dockyard Ltd. The purpose of this lengthy refit was to extend her service life by another five to ten years. As a result, there were no *Hudson* cruises this year. In her place, the *Coriolis II* was again chartered for the Atlantic Zone Monitoring Program (AZMP) and Atlantic Zone Off-Shelf Monitoring Program (AZOMP) cruises.

2020

Hudson remained in refit until mid-August. Due to this delay and the onset of the COVID-19 pandemic, cruises scheduled for the first part of the season had to be cancelled or moved to other Coast Guard and charter vessels. The COVID-19 pandemic also impacted shipboard protocols and all crew and scientific staff had to test negative before sailing.

Cruises

Captains: Fergus Francey/Roy Lockyer/ R. Strowbridge

Number of Cruises: 4

Days at Sea: 54

Nautical Miles Steamed (Estimated): 8,586

Once *Hudson* was operational again at the end of the summer, the first cruise was to the Scotian Shelf, Scotian Slope, Gulf of Maine, Georges Bank and Cabot Strait in support of the whale research and monitoring program (Hilary Moors-Murphy, BIO) (Cruise 2020-066). This work was part of the Species at Risk (SAR), Marine Protected Areas (MPA), National Conservation Plan (NCP), Ocean Protection Plan Marine Environmental Quality (OPP-MEQ) and OPP Real-time Whale Detection and Collision Avoidance (OPP-

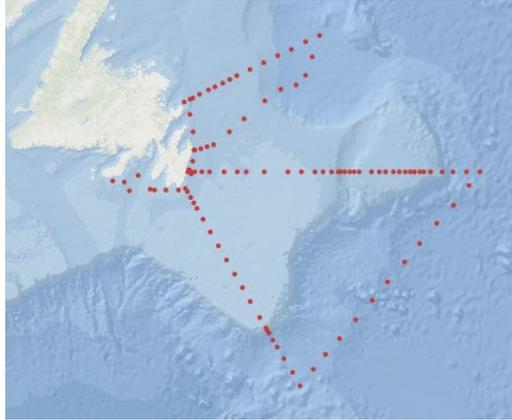
WDCA) science programs. The primary goals were to retrieve and deploy moorings equipped with passive acoustic monitoring (PAM) recorders and conduct marine mammal surveys. The PAM moorings recorded biological, ambient and anthropogenic sounds throughout the year to assess the seasonal occurrence of whales, dolphins and porpoises (including endangered North Atlantic right whales, Northwest Atlantic blue whales and Scotian Shelf northern bottlenose whales, Atlantic fin whales and Sowerby's beaked whales) and supported noise modelling efforts for Atlantic Canadian waters. Mooring deployments and retrievals at two stations were also conducted in support of physical oceanographic monitoring programs. All 26 planned mooring operations (recoveries and deployments) at 15 stations were successfully completed over the eight-day period. In addition, CTD casts were conducted at mooring stations as weather and time permitted. Marine mammal surveys were conducted from the bridge during daylight hours when transiting between stations, as well as when on station. There were 97 sightings of whales, dolphins and porpoises including species at risk such as northern bottlenose, blue, fin and North Atlantic right whales. A video drone (Inspire II) was deployed when on station as weather and time permitted to collect footage of whales and vessel operations. Some testing of equipment, and in particular the new CTD block/display system, was also conducted. On the last day, *Hudson* experienced a critical failure in one its service generators which took about a month to fix.

Next was a multidisciplinary cruise to the Cabot Strait, Laurentian Channel, Scotian Shelf and Scotian Slope which was divided into two legs with a crew and staff exchange partway through at BIO (Lindsay Beazley, BIO) (Cruise 2020-063). Four scientists from Dalhousie University participated. The primary objective was to carry out the annual fall sampling for the Maritimes Region Atlantic Zone Monitoring Program (AZMP). The many secondary objectives included carrying out hydrographic, chemical and biological sampling in the Gully in support of MPA monitoring initiatives, conducting stratified tows with a closing ring net on the Halifax Line to ascertain the depth distribution of zooplankton, measuring nutrients and hydrography in the Northeast Channel and Gulf of Maine as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) Cooperative Agreement, carrying out hydrographic, chemical and biological sampling at stations in the St. Ann's Bank MPA as a continued monitoring effort, conducting hydrographic, chemical and biological sampling across the mouth of the Laurentian Channel and St. Pierre Bank to enhance understanding of hydrographic phenomenon in support of current modeling efforts, deploying six profiling floats in support of the international Argo program, collecting underway and CTD water samples at specified locations and depths to fulfill the regional component of an Aquatic Climate Change Adaptation Services Program (ACCASP) initiative investigating the delineation of ocean acidification and calcium carbonate saturation state in the Atlantic, collecting water samples to evaluate whether and how organic and organometallic micronutrients influence primary productivity and phytoplankton community structure on the Scotian Shelf, collecting water samples from strategic locations and depths to support a microbial community analysis via DNA, RNA and flow cytometry as well as the isolation of novel diazotrophs, collecting water samples from strategic locations and depths for neodymium isotope analyses aimed at elucidating water mass distribution and circulation on the Scotian Shelf and quantifying the contribution of on-shelf nutrient

transport versus local biological processes, collecting seabird and marine mammal observations in fulfillment of Gully and St. Ann's Bank MPA occupation requirements, collecting bottom water samples for eDNA metabarcoding to evaluate benthic species diversity and the presence of invasive species in the Gully MPA, collecting additional nutrient samples at various stations for inter-regional comparison and collecting water samples for the analysis of dissolved inorganic iodate and iodide speciation in shelf and deeper slope waters for comparison to measurements made in Bedford Basin. About 56% of the planned program was lost due to the delay in sailing because of the generator failure on the previous cruise. The cruise terminated in Sydney, NS.

Next was a cruise to the Gulf of St. Lawrence and the St. Lawrence Estuary which started and ended at Gaspé, QC (Sonis Michaud, IML) (Cruise 2020-069). The main goal was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, N₂O, methane, phytoplankton, zooplankton, pH, alkalinity, pCO₂, turbidity, suspended particulate matter and photosynthetic active radiation (PAR). In addition, eleven moorings were retrieved, fourteen moorings were deployed and seabird recruitment studies continued. The remains of a dead whale were observed and samples recovered by Fast Rescue Craft (FRC) for later analysis. Soon after, four orcas were observed in the Strait of Belle Isle. All transects were successfully sampled.

Hudson then steamed to St. John's, NL for the last cruise of the year to St. Pierre Bank, the Grand Banks, Flemish Pass, Northeast Newfoundland Shelf and Southern Labrador Shelf (Stephen Snook, NAFC) (Cruise 2020-071). The primary purpose was to conduct the fall sampling of the standard Atlantic Zone Monitoring Program (AZMP) transects in the Newfoundland and Labrador Region. The transects sampled were the Seal Island, Bonavista, Flemish Cap, Southeast Grand Bank, Station 27 and St. Pierre Bank lines. The usual physical, chemical and biological variables were measured using a CTD Rosette. Water samples were collected and analyzed for carbonate geochemistry in order to determine ocean acidification and saturation parameters. Zooplankton for taxonomic and biochemical analyses were collected by vertical plankton net tows. Acoustic Doppler Current Profiler (ADCP) data were collected while underway along and between transects. Several oceanographic moorings were serviced at Station 27 and in the new Laurentian Channel Marine Protected Area (MPA). In addition, a CTD Rosette was lost in the Laurentian Channel but subsequently recovered by dragging. One acoustic mooring was deployed along the Bonavista Line in support of marine mammal studies. Five Argo floats were also released in support of the international Argo program. The distribution and abundance of seabirds were also observed and recorded. The cruise ended in St. John's, NL.



Available cruise stations for 2020

2021

Hudson was again late from her winter refit. After only five days into the first cruise, she had to return to BIO for further repairs alongside. A fire main pipe rupture had flooded some cabins, propulsion had been lost for four hours and the anchor windlass system had become non-operational. She was not able to return to service until late July. As a consequence of these mechanical problems, planned cruises were canceled and the normal sequence of cruise numbers was disrupted.

Cruises

Captains: Fergus Francey/Darrel London

Number of Cruises: 6

Days at Sea: 84

Nautical Miles Steamed (Estimated): 13,356

The first cruise after repairs were completed was to the Scotian Shelf and Slope for further geological studies (Edward King, BIO) (Cruise 2021-126).

The next cruise was to the Scotian Shelf and Newfoundland Shelf which involved participants from the National Research Council and Dalhousie University (Alice Ortmann, BIO) (Cruise 2021-019). The overall aim was to measure background concentrations of hydrocarbons and microplastics in shelf water along a transect from Newfoundland to Nova Scotia for pollution monitoring. The associated microbial communities were examined using techniques ranging from counts and fluorescence to genomics. A series of on-deck incubations were conducted to characterize the fate, behaviour and effects of oil to provide data and advice for response planning and to gain knowledge to aid the development of biosensors for pollution detection. A parallel series of on-deck incubations were carried out to examine the sensitivity of phytoplankton to different levels of seawater acidity. Marine mammal surveys were also carried out to aid in understanding habitat usage by various species. Some of this work was carried out in Chedabucto Bay which had been the site of the 1970 *Arrow* oil spill. No problems were

encountered with either the vessel or weather so all objectives were fully achieved. A crew change was made near the end of the cruise in Mulgrave, NS.

The next cruise was a return visit to the Scotian Shelf and Slope, Gulf of Maine and Georges Bank in support of the whale research and monitoring program (Hilary Moors-Murphy, BIO) (Cruise 2021-110). The main purpose of this mission was to support ongoing passive acoustic monitoring (PAM) mooring efforts to record biological, ambient and anthropogenic sounds throughout the year. Secondary objectives included servicing a current meter mooring in support of the Atlantic Zone Monitoring Program (AZMP), deploying two tag receiver moorings outside the Gully MPA and a linear array of 15 tag receiver and three range testing moorings spanning 15 km within and just outside the Gully MPA to track tagged juvenile Atlantic halibut as part of the Ocean Tracking Network (OTN) and conducting marine mammal and seabird surveys. In addition, drifting buoys equipped with PAM recorders were deployed to test the effectiveness of the buoy components and configuration, drift patterns and their capabilities for detecting endangered North Atlantic right whales. CTD casts were conducted at each station as time permitted. All objectives were successfully achieved. There were 222 sightings of whales, dolphins and porpoises including species at risk such as northern bottlenose, Sowerby's beaked, blue, fin and North Atlantic right whales.

Next was a short cruise to the Scotian Shelf for more benthic work (Ellen Kenchington, BIO) (Cruise 2021-048). A scientist from the University of Edinburgh also participated. The overall aim was to deploy three benthic landers in the Sambro Bank Sponge Conservation Area. Each lander was equipped with passive acoustic monitoring (PAM) recorders, temperature, salinity and current sensors, a camera system and sediment traps. Prior to deployment, the 4K Camera system was used to survey the seafloor to collect information on sponge density and bottom type. Observations of seabirds and marine mammals were also carried out. The acoustic information was used to characterize ambient noise levels on the sponge grounds and their use by fish, explore fish biodiversity and determine the possible presence of right whales. A notice to fishers was sent out in advance to alert long liners working in the area of the intent of the cruise.

Next was the fall Atlantic Zone Monitoring Program (AZMP) cruise to the Scotian Shelf, Gulf of Maine, Northeast Channel, Laurentian Channel and Cabot Strait (Chantelle Layton, BIO) (Cruise 2021-185). Departure was delayed several days due to a leak in a fire main pipe in the engine room which required immediate repair. Dalhousie students did not participate this year due to a recent investigation into safety concerns regarding *Hudson* and potential personal liability issues. Presence of fishing vessels and gear along the intended cruise track influenced operations. The primary objective was to obtain observations of the hydrography and distribution of nutrients, phytoplankton and zooplankton at the standard sampling stations along the standard Atlantic Zone Monitoring Program (AZMP) sections within the Maritimes Region. Secondary objectives were to carry out hydrographic, chemical and biological sampling at stations in the Gully in support of MPA monitoring initiatives, conduct stratified tows with a closing ring net to ascertain the depth distribution of zooplankton, measure nutrients and

hydrography across the Northeast Channel and Gulf of Maine as part of the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) Cooperative Agreement, carry out hydrographic, chemical and biological sampling at stations in the St. Ann's MPA as a continuing monitoring effort, conduct hydrographic, chemical and biological sampling across the mouth of the Laurentian Channel and St. Pierre Bank to enhance our understanding of hydrographic phenomenon in support of current modelling efforts, deploy three profiling floats in support of the international Argo program, seabird and marine mammal observations in fulfillment of Gully and St. Ann's Bank MPA occupation requirements, collect additional nutrient samples at various stations for inter-regional comparison and collect water samples at specified locations and depths to fulfill the regional component of an Aquatic Climate Change Adaptation Services Program (ACCASP) initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic. Despite a number of minor setbacks to the program, all objectives were achieved. This was the first time since 2018 that all AZMP lines were completely sampled. The cruise ended in Sydney, NS.

This was followed by a cruise to the Gulf of St. Lawrence and St. Lawrence Estuary which started and ended at Gaspé, QC (David Leblanc, IML) (Cruise 2021-077). The main goal was to carry out the annual fall sampling for the Atlantic Zone Monitoring Program (AZMP) and the annual fall ice forecasting program along the standard sections. The usual physical, chemical and biological variables were measured using a CTD Rosette and plankton nets. These included temperature, salinity, chlorophyll, nutrients, dissolved oxygen, N₂O, methane, phytoplankton, zooplankton, pH, alkalinity, pCO₂, turbidity, suspended particulate matter and photosynthetic active radiation (PAR). In addition, eleven moorings were retrieved, thirteen moorings were deployed and seabird recruitment studies continued. During the cruise, a stop was made at Pictou, NS to pick up a crew member. All transects were successfully sampled.

While not realized at the time, this turned out to be *Hudson's* final cruise for soon after, on 5 November, *Hudson* suffered serious propulsion problems while entering the harbor at St. John's, NL to prepare for the next cruise. After assessing the situation, due to the scale of the problem and the time and cost to repair it, combined with the costs associated with an upcoming period of regulatory compliance work, the Coast Guard decided that the aged *Hudson* was now well beyond economical repair and that further investment would not allow her to return to reliable service. She remained in St. John's for the rest of year.

2022

On 19 January, the Coast Guard formally announced that *Hudson* had reached the end of her service and would be decommissioned. While not unexpected, this caused quite a shock to the Canadian oceanographic community. Shortly after, she steamed from St. John's back to BIO and arrived 24 January. She was escorted up the harbour by another Coast Guard vessel while many watched her final arrival from shore with fond memories. This was the last time she tied up at BIO.



CCGS Hudson's final return to BIO in 2022 (Credit BIO Photo Unit)

In May, Captain Fergus Francey organized a three-day open house on board *Hudson* for those wishing to walk the decks and alleyways one more time and say farewell to a faithful friend. This event was well attended and many fond memories and stories were rekindled and exchanged.

A formal decommissioning ceremony was held on 7 July at BIO which involved senior members of the Coast Guard, ship's crew, selected BIO scientists, DFO Communications and the media. This began in the Ford Auditorium and the program included remarks by Ellen Kenchington of DFO, Stephen Locke of NRCan and unofficial *Hudson's* historian retired Captain Richard Smith. In addition, a video describing some of the *Hudson's* history, prepared by the Coast Guard with the assistance of BIO scientists, was shown. After this formal ceremony, those assembled moved down to the jetty for the lowering of the Coast Guard ensign on the bow of the *Hudson* after which a reception was held under a marquee on the jetty. It was a most fitting farewell for a legendary oceanographic research vessel.



CCGS Hudson's decommissioning ceremony (Credit BIO Photo Unit)

During the summer and fall, numerous items of scientific and ship equipment still useful were removed for use on other vessels. In addition, numerous mementos were reclaimed for later display in the Coast Guard building and BIO.

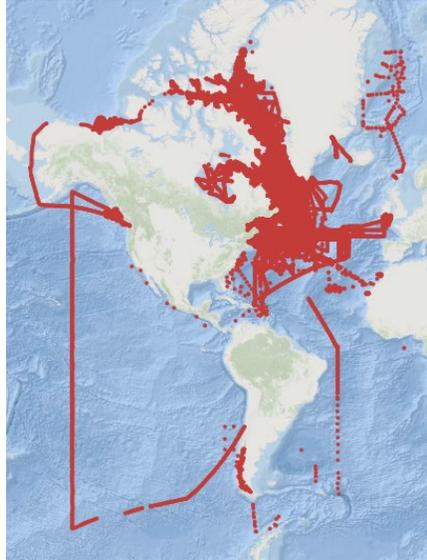
During the fall, the Coast Guard announced that *Hudson*, when ready, would be towed to Sheet Harbour, NS for demolition. On 19 December, she left BIO under tow for the last time, almost 59 years to the day after she first arrived from Saint John, NB. She was temporarily tied up on the Halifax side of the Narrows.

2023

During the summer, *Hudson* left Halifax Harbour for the last time and was towed to the R.J. MacIsaac Construction Ltd. shipyard in Sheet Harbour for demolition after all oils, fluids and other hazardous materials were removed.

Summary

Over her entire seagoing career of 59 years, *Hudson* carried out 475 cruises, an average of 8 per year. In so doing she spent a total of 9,863 days at sea or an average of 167 days per year. The total distance steamed while carrying out cruises is estimated to be 1,565,169 nautical miles (2,898,692 km) which is an average of 26,528 nautical miles (49,130 km) per year. This distance is equivalent to sailing 72 times around the world at the Equator! An impressive accomplishment indeed. As seen in the composite plot below (1964-2022), most of her cruises were to the North Atlantic, Atlantic Canada and the eastern Arctic but she also circumnavigated the Americas, passed twice through the Northwest Passage and once through the Panama Canal. Most *Hudson* cruises were in support of BIO programs but quite a few were organized by other Canadian government labs and universities.



Available cruise stations/tracks for 1964-2023

Over her career, *Hudson* was commanded by 39 captains, some permanent and others relief. Those with over 200 days at sea are shown below.

| Name | Period | Days at Sea |
|---------------|-----------|-------------|
| F. Mauger | 1970-1988 | 1490 |
| L. Strum | 1976-1993 | 1214 |
| D. Deer | 1971-1978 | 795 |
| D. Butler | 1969-1974 | 627 |
| W. Kettle | 1966-1968 | 549 |
| J. Vieau | 1964-1966 | 378 |
| P. Bragg | 2005-2011 | 339 |
| M. Marsden | 1998-2000 | 263 |
| L. Rhodenizer | 1996-2000 | 247 |
| R. Cotie | 2013-2018 | 233 |
| F. Francey | 2008-2021 | 209 |

By far the longest serving captain was Fred Mauger, followed by Lorne Strum.

During her travels, *Hudson* visited 41 Canadian ports and 34 foreign ports to exchange personnel, pick up equipment, take on provisions and provide the crew with a shore break. The most visited port was St. John's, NL which was almost a second home and where she was a familiar sight steaming into the harbour through the narrows. She also visited numerous Canadian ports in Nova Scotia, New Brunswick, Prince Edward Island, Quebec, Newfoundland and Labrador, British Columbia, the Northwest Territories and Nunavut. The first and most frequently visited foreign port was St. George's, Bermuda. Other foreign ports visited were in Greenland, Iceland, the UK, Portugal, the Canary Islands, the Azores, numerous islands in the Caribbean, Brazil, Argentina, Chile, Tahiti,

Panama, Costa Rica, Guatemala and Mexico. Surprisingly, *Hudson* only visited one US port and that was San Diego, CA. She indeed was a world traveller and a fitting ambassador for Canada.

Over her lifetime of working at sea, 148 scientists from all oceanographic disciplines served as chief scientist. Those who served in this capacity for more than 100 days at sea are listed below.

| Name | Period | Days at Sea |
|----------------|---------------|--------------------|
| A. Clarke | 1976-2003 | 413 |
| J. Lazier | 1966-1996 | 344 |
| E. Colbourne | 1994-2018 | 341 |
| D. Piper | 1974-2006 | 310 |
| B. Loncarevic | 1964-1988 | 293 |
| E. Horne | 1999-2013 | 276 |
| B. MacLean | 1973-1993 | 272 |
| G. Harrison | 1985-2010 | 220 |
| I. Yashayev | 2004-2018 | 215 |
| T. Platt | 1980-1990 | 210 |
| B. Pelletier | 1964-1974 | 173 |
| C. Mann | 1967-1970 | 167 |
| C. Keen | 1972-1987 | 166 |
| S. Srivastava | 1974-1992 | 148 |
| R. Hendry | 1982-1991 | 145 |
| E. Head | 1998-2007 | 137 |
| E. Kenchington | 2007-2021 | 135 |
| P. Davies | 1995-1997 | 113 |
| D. Ross | 1968-1974 | 112 |
| L. King | 1967-1979 | 111 |
| R. Jackson | 1991-2003 | 107 |

The chief scientist spending the greatest number of days at sea was the physical oceanographer Allyn Clarke.

Hudson more than lived up to all expectations when she arrived at BIO in 1963. She soon developed an international reputation as a superb platform for conducting any kind of multidisciplinary oceanographic research under any weather conditions and became the envy of other oceanographic labs around the world. It did not take long for her to become the queen of the Canadian research vessel fleet and an icon for BIO. The firm of Gilmore, German and Milne in Montreal had indeed designed an outstanding oceanographic research vessel. Of all her many positive characteristics, the most important was her outstanding sea kindness which allowed her to work under the extreme weather conditions which often occur in the North Atlantic and eastern Canadian Arctic while other research vessels were forced to heave-to or head for port. *Hudson* was

well-loved by all who had the privilege to sail on her. While a successor vessel is now under construction, she can never be replaced.

Using the vast amount of information collected using *Hudson* over her long career, Canadian oceanographers have made a huge number of important scientific discoveries which have greatly advanced our knowledge of the ocean. Significant accomplishments were made in a broad range of marine science disciplines including ocean engineering, hydrography, marine geophysics, marine geology, physical oceanography, chemical oceanography, biological oceanography, fisheries, marine mammals, marine pollution, ocean monitoring and marine management. Many of these studies were done in collaboration with scientists from other countries and part of major international programs. The new information collected using *Hudson* not only advanced our fundamental understanding of ocean properties and dynamics but it has also been applied to address important marine management issues in Canadian marine waters. Products have included new instrumentation, charts, maps, scientific publications, technical reports, computer models, technical reports and data bases. Few if any other oceanographic research vessels in the world have had a greater impact in developing our knowledge of the oceans.

The longevity of *Hudson*'s working life as a research vessel, 59 years, is quite remarkable and due to the quality of her design and construction as well as the considerable effort put into maintaining her in later years. The only other Canadian research vessel approaching this life span was *Acadia* which conducted hydrographic surveys for 56 years (1913-1969) for the Canadian Hydrographic Service (CHS). However, *Hudson*'s life span was superseded by *Atlantis*. She was the primary research vessel of the Woods Hole Oceanographic Institution (WHOI) for 36 years (1930-1966) and then was sold to the Argentinian Navy who operated her as a research vessel, renamed *El Austral*, for another 40 years giving her a total working life of 76 years which exceeds that of *Hudson* by 17 years. The well-known *Vema*, a workhorse for geophysical research operated by the Lamont-Doherty Earth Observatory, had a working life as a research vessel of only 28 years.

Acknowledgements

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APPENDIX

TABLE OF ALL HUDSON CRUISES (1964-2021)

This table contains basic information on all the scientific cruises carried out using *Hudson* over her long career. The details include year, cruise number, dates, days at sea, captain, chief scientist, location and general program. The sponsoring agencies, in order of appearance, are defined as follows:

BIO, Bedford Institute of Oceanography; DAL, Dalhousie University; SABS, St. Andrews Biological Station; McG, McGill University; DND, Department of National Defence; MSB, Marine Sciences Branch; UBC, University of British Columbia; GSC, Geological Survey of Canada; CHS, Canadian Hydrographic Service; MUN, Memorial University of Newfoundland; NAFC, Northwest Atlantic Fisheries Service; IOS, Institute of Ocean Sciences; UQAM, University of Quebec at Montreal; GIROQ, Groupe Interuniversitaire de Recherches du Quebec; LVL, University of Laval; IML, Institut Maurice-Lamontagne.

| Year | Cruise | Start | Days | Captain | Chief Scientist | Area | Program |
|------|---------------|--------|------|-----------------------|----------------------------------|--|---------------------------------|
| 1964 | 0464 | 23 Mar | 35 | J. Vieau | L. Murdock, BIO | Tail of the Bank | Hydrography |
| 1964 | 0764 | 14 May | 5 | J. Vieau | L. Murdock, BIO | Tail of the Bank | Hydrography |
| 1964 | 1364 | 6 Jun | 6 | J. Vieau | B. Pelletier, BIO | Gulf of St. Lawrence | Geophysics Geology |
| 1964 | 2764 | 5 Nov | 8 | J. Vieau | B. Loncarevic, BIO | Laurentian Channel | Geophysics |
| 1964 | 2964 | 16 Nov | 9 | J. Vieau | T. Foote, BIO | Gulf of St. Lawrence | Physics |
| 1964 | 3064 | 7 Dec | 13 | J. Vieau | C. Boyd, DAL | Scotian Shelf Sohm Abyssal Plain | Biology |
| 1965 | 165 | 6 Jan | 7 | J. Vieau | T. Foote, BIO | Sargasso Sea | Physics |
| 1965 | 365 | 1 Feb | 26 | J. Vieau | N. Tibbo, SABS | Cape Hatteras Caribbean | Fisheries |
| 1965 | 665 | 8 Mar | 54 | J. Vieau | B. Loncarevic, BIO | Northwest Atlantic | Geophysics |
| 1965 | 1565 | 31 May | 28 | J. Vieau | C. Boyd, DAL | Scotian Shelf | Biology |
| 1965 | 2465 | 16 Jul | 72 | J. Vieau | B. Pelletier, BIO | Sargasso Sea Hudson Bay | Hydrography Geology |
| 1965 | 3065 | 7 Oct | 24 | J. Vieau | G. Hobson, BIO | Gulf of St. Lawrence | Geophysics |
| 1965 | 3465 | 20 Nov | 11 | J. Vieau | B. Loncarevic, BIO | Nova Scotian Continental Margin | Geophysics |
| 1966 | 266 | 12 Mar | 51 | J. Vieau M. Wagner | J. Lazier, BIO | Labrador Sea Irminger Sea | Physics Chemistry Biology |
| 1966 | 1066 | 14 May | 20 | W. Kettle | B. Loncarevic, BIO | Kelvin Seamount | Geophysics |
| 1966 | ??? | 13 Jun | 25 | W. Kettle | M. Keen, DAL | Newfoundland Continental Margin | Geophysics |
| 1966 | 1966 | 20 Jul | 60 | W. Kettle | B. Loncarevic, BIO | Mid-Atlantic Ridge | Geophysics |
| 1966 | 2666 | 30 Sep | 6 | W. Kettle | J. Marlowe, BIO | The Gully | Geology |
| 1967 | 267 | 16 Jan | 79 | W. Kettle | C. Mann, BIO | East Greenland Sea Denmark Strait Irminger Sea | Physics |
| 1967 | 1067 | 26 Apr | 14 | W. Kettle | R. Gilbert, BIO | Montreal | Expo 1967 |
| 1967 | 1267 | 13 May | 10 | W. Kettle | R. Trites, BIO | Scotian Shelf The Gully | Geology Physics |
| 1967 | 1967 Leg 1 | 10 Jun | 18 | W. Kettle | R. Gilbert, BIO | San Pablo Seamount | Engineering Biology |
| 1967 | 1967 Leg 2 | 4 Jul | 15 | W. Kettle | R. Gilbert, BIO | Grand Banks Flemish Cap | Engineering Biology |
| 1967 | 2467 | 7 Aug | 24 | W. Kettle | M. Dunbar, McG D. Loring, BIO | Gulf of St. Lawrence | Physics Geology Biology |
| 1967 | 2767 | 11 Sep | 9 | W. Kettle | L. King, BIO | Scotian Shelf | Geology |
| 1967 | 3167 | 10 Oct | 20 | W. Kettle | J. Butters, DND | Sargasso Sea | Physics |

| | | | | | | | |
|------|-----------|--------|-----|-----------------------------------|--------------------|--|--|
| 1968 | 668 | 24 Jan | 78 | W. Kettle | J. Marlowe, BIO | Caribbean | Hydrography Geology Physics Biology Geophysics |
| 1968 | 2268 | 6 May | 19 | W. Kettle | B. Loncarevic, BIO | Bermuda Banks | Geophysics |
| 1968 | Leg 1 | | | | | | |
| 1968 | Leg 2 | 1 Jun | 108 | W. Kettle | B. Loncarevic, BIO | Mid-Atlantic Ridge | Geophysics |
| 1968 | 3968 | 1 Oct | 16 | W. Kettle | J. Brooke, BIO | San Pablo Seamount Rehoboth Seamount | Engineering |
| 1968 | 5868 | 19 Oct | 1 | W. Kettle | D. Ross, BIO | Scotian Shelf | Geophysics |
| 1968 | 6168 | 28 Oct | 10 | W. Kettle | R. Fournier, DAL | Sargasso Sea | Biology |
| 1968 | 6068 | 18 Nov | 17 | W. Kettle | C. Mason, BIO | Rehoboth Seamount | Engineering |
| 1969 | 69-020 | 17 Apr | 2 | D. Butler | J. Brooke, BIO | Scotian Shelf | Engineering |
| 1969 | 69-024 | 23 Apr | 9 | D. Butler | P. Wangersky, DAL | Sargasso Sea | Chemistry Biology |
| 1969 | 69-025 | 12 May | 58 | D. Butler | B. Pelletier, BIO | North Atlantic | Geophysics Geology |
| 1969 | 69-044 | 4 Aug | 10 | D. Butler | C. Mason, BIO | Scotian Shelf | National Film Board |
| 1969 | 69-047 | 18 Aug | 21 | D. Butler | J. Butters, DND | Sargasso Sea | Physics |
| 1969 | 69-040 | 8 Sep | 29 | D. Butler | R. Gees, DAL | ??? | Geology |
| 1969 | 69-046 | 3 Nov | 4 | D. Butler | C. Mann, BIO | Scotian Shelf | Physics |
| 1969 | 69-050 | 19 Nov | 25 | D. Butler | C. Mann, BIO | North Atlantic | Geophysics |
| | Hudson 70 | | | | | South Atlantic | Geology Physics |
| | Leg 1 | | | | | | Chemistry Biology |
| 1969 | Hudson 70 | 20 Dec | 27 | D. Butler | C. Mann, BIO | South Atlantic | Geology Physics |
| | Leg 2 | | | | | | Chemistry Biology |
| 1970 | Hudson 70 | 22 Jan | 32 | D. Butler | C. Mann, BIO | South Atlantic | Geology Physics |
| | Leg 3 | | | | | Drake Passage | Chemistry Biology |
| 1970 | Hudson 70 | 1 Mar | 38 | D. Butler | G. Pickard, UBC | Chilean Fjords | Physics Biology |
| 1970 | Hudson 70 | 15 Apr | 28 | D. Butler | R. Melanson, BIO | South Pacific | Geophysics Geology Physics Chemistry Biology |
| | Leg 4 | | | | | | Geophysics Geology Physics Chemistry Biology |
| | Leg 5 | | | | | | Geology Physics Chemistry Biology |
| 1970 | Hudson 70 | 16 May | 26 | D. Butler | W. Campbell, MSB | South Pacific North Pacific | Geophysics Geology Physics Chemistry Biology |
| | Leg 6 | | | | | | Geophysics Geology Physics Chemistry Biology |
| 1970 | Hudson 70 | 12 Jul | 24 | F. Mauger | C. Maunsell, BIO | North Pacific | Geophysics Geology |
| 1970 | Hudson 70 | 13 Aug | 40 | D. Butler | B. Pelletier, BIO | North Pacific Arctic | Geophysics Geology Physics Chemistry Biology |
| | Leg 7 | | | | | | Geophysics Geology Physics Chemistry Biology |
| | Leg 8 | | | | | | Geophysics Geology Physics Chemistry Biology |
| 1970 | Hudson 70 | 30 Sep | 17 | D. Butler | D. Ross, BIO | Arctic North Atlantic | Geophysics Geology Chemistry Biology |
| | Leg 9 | | | | | | Geophysics Geology |
| 1971 | 71-014 | 19 Apr | 38 | D. Butler D. Deer M. Wagner | L. King, BIO | Scotian Shelf Gulf of Maine Bay of Fundy | Geophysics Geology |
| 1971 | 71-022 | 14 Jun | 51 | D. Butler | F. Aumento, DAL | Mid-Atlantic Ridge | Geophysics |
| 1971 | 71-032 | 19 Aug | 64 | D. Butler | D. Ross, BIO | Eastern Arctic | Geophysics |
| 1971 | 71-037 | 15 Nov | 10 | ??? | C. Maunsell, BIO | Northwest Atlantic | Physics Geology Physics |
| 1972 | 72-001 | 6 Jan | 4 | M. Wagner | D. Dobson, BIO | Placentia Bay Newfoundland | Physics |
| 1972 | 72-008 | 12 Apr | 60 | D. Butler | B. Reiniger, BIO | Tail of Grand Banks | Physics |
| 1972 | 72-021 | 5 Jul | 30 | D. Butler | C. Keen, BIO | Nova Scotian Continental Margin | Geophysics |
| 1972 | 72-025 | 28 Sep | 31 | M. Wagner | R. Macnab, BIO | Labrador Sea | Hydrography |

| | | | | | | | | |
|------|--------|--------|----|------------|--------------------|--|--|-------------|
| | | | | | | | Southern Margin of Grand Banks | Geophysics |
| 1972 | 72-036 | 2 Nov | 5 | ??? | B. Loncarevic, BIO | | Scotian Shelf | Geophysics |
| 1973 | 73-002 | 22 Jan | 15 | M. Wagner | D. Gordon, BIO | | Halifax-Bermuda Section | Chemistry |
| | Leg 1 | | | | | | | Biology |
| 1973 | 73-002 | | | M. Wagner | K. Manchester, BIO | | Halifax-Bermuda Section | Geology |
| | Leg 2 | | | | | | | Biology |
| 1973 | 73-004 | 12 Feb | 25 | M. Wagner | M. Hassan, BIO | | Gulf of St. Lawrence | Physics |
| 1973 | 73-006 | 2 Apr | 17 | M. Wagner | B. MacLean, BIO | | Laurentian Channel | Geology |
| | | | | | | | St. Pierre Bank | |
| | | | | | | | Burgeo Bank | |
| 1973 | 73-011 | 25 Apr | 23 | M. Wagner | C. Keen, BIO | | Nova Scotia Continental Margin Grand Banks | Geophysics |
| | Leg 1 | | | | | | | |
| 1973 | 73-011 | 23 May | 22 | M. Wagner | C. Keen, BIO | | Nova Scotia Continental Margin Grand Banks | Geophysics |
| | Leg 2 | | | | | | | |
| 1973 | 73-016 | 23 Jun | 23 | D. Deer | L. King, BIO | | Cape Breton Shelf | Geology |
| | | | | | | | Laurentian Channel | |
| | | | | | | | St. Pierre Bank | |
| | | | | | | | Burgeo Bank | |
| 1973 | 73-025 | 2 Aug | 55 | D. Deer | C. Ross, BIO | | Denmark Strait | Physics |
| 1973 | 73-031 | 15 Oct | 29 | D. Deer | C. Boyd, DAL | | Scotian Shelf | Geology |
| | | | | | | | Gulf Stream | Physics |
| | | | | | | | Labrador Coast | Chemistry |
| | | | | | | | | Biology |
| 1974 | 74-003 | 22 Jan | 18 | D. Butler | F. Aumento, DAL | | Mid-Atlantic Ridge | Geophysics |
| | Leg 1 | | | | | | | |
| 1974 | 74-003 | 10 Feb | 16 | D. Butler | C. Mason, BIO | | Sargasso Sea | Engineering |
| | Leg 2 | | | | | | | |
| 1974 | 74-003 | 27 Mar | 3 | D. Butler | D. McKeown, BIO | | Off Halifax | Engineering |
| | Leg 3 | | | | | | Bedford Basin | |
| 1974 | 74-006 | 30 Mar | 27 | D. Deer | E. Hassan, BIO | | Gulf of St. Lawrence | Physics |
| | Leg 1 | | | | | | St. Lawrence River | |
| | | | | | | | Saguenay River | |
| 1974 | 74-006 | 29 Apr | 16 | D. Deer | M. Bewers, BIO | | Gulf of St. Lawrence | Chemistry |
| | Leg 2 | | | | | | Saguenay River | |
| | | | | | | | Cabot Strait | |
| 1974 | 74-021 | 10 Jun | 17 | D. Deer | D. Piper, DAL | | Continental Margin Grand Banks | Geology |
| | | | | | | | Newfoundland Seamounts | |
| 1974 | 74-026 | 17 Jul | 30 | D. Deer | D. Ross, BIO | | Eastern Arctic | Geophysics |
| | Leg 1 | | | | | | | Geology |
| 1974 | 74-026 | 31 Aug | 26 | D. Deer | B. Pelletier, BIO | | Eastern Arctic | Geophysics |
| | Leg 2 | | | | | | | Geology |
| 1974 | 74-026 | 26 Sep | 36 | D. Deer | S. Srivastava, BIO | | Eastern Arctic | Geophysics |
| | Leg 3 | | | | | | | Geology |
| 1975 | 75-006 | 22 Mar | 13 | D. Deer | C. Mason, BIO | | Sargasso Sea | Engineering |
| 1975 | 75-007 | 11 Apr | 13 | D. Deer | D. McKeown, BIO | | Emerald Basin | Engineering |
| 1975 | 75-009 | 25 Apr | 35 | D. Deer | G. Fader, BIO | | Grand Banks | Geology |
| | Leg 1 | | | | | | Flemish Cap | |
| 1975 | 75-009 | 2 Jun | 31 | D. Deer | C. Keen, BIO | | Newfoundland Basin | Geophysics |
| | Leg 2 | | | | | | Margin of Grand Banks | |
| 1975 | 75-009 | 21 Jul | 30 | D. Deer | R. Haworth, BIO | | Gulf of St. Lawrence | Geophysics |
| | Leg 3 | | | | | | Northeast of Newfoundland | |
| 1975 | 75-009 | 24 Aug | 20 | D. Deer | R. Fillon, BIO | | Labrador Sea | Geophysics |
| | Leg 4 | | | | | | Davis Strait | |
| 1975 | 75-009 | 14 Sep | 28 | D. Deer | S. Srivastava, BIO | | Labrador Sea | Geophysics |
| | Leg 5 | | | | | | Davis Strait | |
| 1976 | 76-002 | 23 Feb | 46 | D. Deer | A. Clarke, BIO | | Labrador Sea | Physics |
| | | | | | | | | Chemistry |
| 1976 | 76-006 | 20 Apr | 8 | D. Deer | M. Bewers, BIO | | St. Lawrence Estuary | Chemistry |
| | | | | | | | Saguenay Fjord | |
| 1976 | 76-008 | 29 Apr | 8 | D. Deer | M. Dunbar, McG | | St. Lawrence Estuary | Physics |
| | | | | | | | | Biology |
| 1976 | 76-013 | 17 May | 10 | D. Deer | D. McKeown, BIO | | Emerald Basin | Engineering |
| | | | | | | | Shelf Break | Engineering |
| 1976 | 76-016 | 7 Jun | 16 | C. DeVries | L. King, BIO | | Gulf of Maine | Geology |
| 1976 | 76-020 | 28 Jun | 16 | D. Deer | P. Smith, BIO | | Scotian Shelf | Physics |
| | | | | | | | Scotian Slope | Biology |
| 1976 | 76-023 | 23 Jul | 27 | L. Strum | R. Falconer, BIO | | Eastern Arctic | Geophysics |

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| 1976 | 76-025 | 19 Aug | 25 | L. Strum | M. Lewis, GSC | Lancaster Sound | Geophysics Geology |
| 1977 | 77-005 | 13 Apr | 9 | D. Deer | D. McKeown, BIO | Scotian Shelf | Engineering |
| 1977 | 77-007 | 28 Apr | 14 | L. Strum | A. Herman, BIO | Scotian Shelf Scotian Slope | Biology |
| 1977 | 77-011 | 12 May | 21 | D. Deer | L. King, BIO G. Fader, BIO | Grand Banks Flemish Cap | Geology |
| 1977 | 77-014 | 5 June | 18 | D. Deer | C. Keen, BIO | Newfoundland Continental Margin | Geophysics |
| 1977 | 77-018 | 11 Jul | 4 | D. Deer | P. Kingston, BIO | Sambro Bank | Engineering |
| 1977 | 77-021 | 25 Jul | 28 | L. Strum | R. Fillon, BIO | Labrador Shelf Saglek Bank | Geology |
| 1977 | 77-024 | 22 Aug | 26 | D. Deer | P. Jones, BIO | Labrador Sea Davis Strait Baffin Bay Lancaster Sound Jones Sound Smith Sound | Geophysics Chemistry |
| 1977 | 77-027 | 18 Sep | 25 | L. Strum | B. MacLean, BIO | Baffin Island Continental Shelf | Geophysics Geology |
| 1977 | 77-029 | 13 Oct | 21 | L. Strum | J. Lazier, BIO | Labrador Shelf Labrador Slope | Physics Chemistry Biology Physics |
| 1978 | 78-002 Leg 1 | 20 Jan | 19 | D. Deer | J. Lazier, BIO | Labrador Shelf Labrador Slope Labrador Sea | Physics |
| 1978 | 78-002 Leg 2 | 10 Feb | 20 | D. Deer | J. Lazier, BIO | Labrador Shelf Labrador Slope Labrador Sea | Physics |
| 1978 | 78-002 Leg 3 | 7 Mar | 24 | D. Deer | A. Clarke, BIO | Labrador Shelf Labrador Slope Labrador Sea | Physics |
| 1978 | 78-002 Leg 4 | 2 Apr | 12 | D. Deer | A. Clarke, BIO | Labrador Shelf Labrador Slope Labrador Sea | Physics |
| 1978 | 78-002 Leg 5 | 14 Apr | 6 | L. Strum | J. Lazier, BIO | Labrador Shelf Labrador Slope Labrador Sea | Physics |
| 1978 | 78-008 | 27 Apr | 15 | D. Deer | D. McKeown, BIO | Scotian Shelf Laurentian Channel Placentia Bay | Engineering |
| 1978 | 78-012 | 15 May | 15 | D. Deer | G. Peters, MUN | Placentia Bay | Geology |
| 1978 | 78-016 | 2 Jun | 19 | D. Deer | M. Bewers, BIO | Western North Atlantic | Chemistry |
| 1978 | 78-020 | 27 Jun | 22 | L. Strum | C. Keen, BIO | Nova Scotia Continental Margin Orphan Knoll Basin Labrador Shelf | Geophysics |
| 1978 | 78-023 | 20 Jul | 22 | D. Deer | R. Haworth, BIO | Newfoundland Shelf | Geophysics Geology |
| 1978 | 78-026 | 25 Aug | 22 | D. Deer | E. Levy, BIO | Scott Inlet Buchan Gulf Lancaster Sound North Water | Chemistry Biology |
| 1978 | 78-029 | 17 Sep | 35 | D. Deer | B. MacLean, BIO | Baffin Bay Davis Strait | Geophysics Geology |
| 1978 | 78-032 | 23 Oct | 7 | ??? | J. Lazier, BIO | Hamilton Bank | Physics |
| 1979 | 79-001 | 8 Jan | 22 | L. Strum | C. Ross, BIO | Flemish Cap | Physics |
| 1979 | 79-00? | 5 Feb | 54 | L. Strum | B. Paul, NAFC | Hamilton Bank | Fisheries Surveillance |
| 1979 | 79-00? | 23 Mar | 3 | L. Strum | R. Trites, BIO | Scotian Shelf | Physics Chemistry Biology |
| 1979 | 79-006 | 18 Apr | 15 | F. Mauger | R. Conover, BIO | Scotian Shelf Scotian Slope | Biology |
| 1979 | 79-011 Leg 1 | 14 May | 9 | F. Mauger | D. McKeown, BIO | Scotian Shelf Scotian Slope Gulf Stream Grand Banks | Engineering |
| 1979 | 79-011 Leg 2 | 24 May | 15 | F. Mauger | L. King, BIO | Placentia Bay Scotian Shelf | Geology |

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| 1979 | 79-013 | 18 Jun | 22 | F. Mauger | S. Srivastava, BIO | Southwest Greenland Margin Labrador Sea | Geophysics |
| 1979 | 79-017 | 13 Jul | 8 | F. Mauger | C. Schafer, BIO | East Newfoundland Basin and Slope | Geology |
| 1979 | 79-018 | 21 Jul | 16 | F. Mauger | G. Vilks, BIO | Labrador Shelf Hamilton Inlet | Geology Chemistry Biology |
| 1979 | 79-019 | 9 Aug | 17 | F. Mauger | R. Fillon, BIO | Labrador Shelf | Geology |
| 1979 | 79-020 | 26 Aug | 6 | F. Mauger | J. Lazier, BIO | Hamilton Bank | Physics |
| 1979 | 79-025 | 7 Sep | 28 | F. Mauger | B. Reiniger, BIO | Gulf Stream | Physics |
| 1980 | 80-002 | 2 Jan | 8 | F. Mauger | C. Ross, BIO | Mid-Atlantic Ridge, Flemish Cap | Physics |
| 1980 | 80-010 | 21 Apr | 30 | L. Strum | G. Fader, BIO | Avalon Channel Scotian Shelf Grand Banks | Geophysics Geology |
| 1980 | 80-016 | 26 May | 32 | L. Strum | D. McKeown, BIO | Northwest Newfoundland Shelf Sohm Abyssal Plain | Engineering Geology |
| 1980 | 80-026 | 14 Jul | 11 | F. Mauger | J. Lazier, BIO | Mid-Atlantic Ridge Hamilton Bank | Physics Biology |
| 1980 | 80-027 | 24 Jul | 36 | F. Mauger | T. Platt, BIO | Labrador Sea Davis Strait Baffin Bay Melville Sound Lancaster Sound Jones Sound Kane Basin | Biology |
| 1980 | 80-028 | 29 Aug | 42 | F. Mauger | B. MacLean, BIO | Baffin Bay Davis Strait | Geology Chemistry |
| 1980 | 80-035 | 10 Oct | 17 | F. Mauger | H. Boudreau, BIO | Davis Strait Labrador Shelf | Hydrography Geophysics |
| 1980 | 80-037 | 26 Oct | 7 | F. Mauger | J. Lazier, BIO | Hamilton Bank | Physics |
| 1981 | 81-001 | 27 Feb | 17 | F. Mauger | R. Pocklington, BIO | North Atlantic Caribbean | Geology Chemistry Biology |
| 1981 | 81-002 | 19 Mar | 20 | F. Mauger | T. Platt, BIO | North Pacific | Biology |
| 1981 | 81-003 | 9 Apr | 31 | F. Mauger | C. Wong, IOS | North Pacific | Geophysics Geology Chemistry |
| 1981 | 81-017 | 16 May | 14 | F. Mauger | R. Chase, UBC | Juan de Fuca Ridge Explorer Seamount | Geophysics Geology |
| 1981 | 81-021 | 30 May | 11 | F. Mauger | C. Yorath, IOS | Hecate Strait Queen Charlotte Sound | Geophysics Geology |
| 1981 | 81-022 | 10 Jun | 11 | F. Mauger | R. Hyndman, IOS | Queen Charlotte Sound | Geophysics |
| 1981 | 81-027 | 1 Jul | 92 | F. Mauger | A. O'Connor, IOS | Beaufort Sea Northwest Passage | Hydrography |
| 1981 | 81-045 | 1 Oct | 34 | F. Mauger | M. Lewis, BIO | Lancaster Sound Davis Strait Labrador Sea Grand Banks | Geophysics Geology |
| 1981 | 81-046 | 6 Nov | 10 | F. Mauger | B. Reiniger, BIO | Newfoundland Basin | Physics |
| 1982 | 82-001 | 14 Feb | 55 | F. Mauger | A. Clarke, BIO | Norwegian Sea, Greenland Sea | Physics |
| 1982 | 82-002 | 11 Apr | 21 | F. Mauger | R. Hendry, BIO | North Atlantic | Physics |
| 1982 | 82-014 | 25 May | 16 | F. Mauger | K. Manchester, BIO | Scotian Shelf Scotian Slope | Geophysics Geology |
| 1982 | 82-018 | 15 Jun | 20 | F. Mauger | D. Buckley, BIO | Nares Abyssal Plain | Geology Biology |
| 1982 | 82-022 | 7 Jul | 19 | F. Mauger | P. Ryall, DAL | North Atlantic | Geology Chemistry Biology |
| 1982 | 82-027 | 12 Aug | 27 | F. Mauger | P. Jones, BIO | Labrador Shelf Ungava Bay Hudson Strait Hudson Bay Foxe Basin Baffin Bay | Physics Chemistry Biology |
| 1982 | 82-031 | 9 Sep | 15 | F. Mauger | C. Schafer, BIO | Baffin Bay | Geophysics Geology |

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| 1982 | 82-034 | 24 Sep | 24 | F. Mauger | B. MacLean, BIO | Baffin Bay Davis Strait | Geophysics Geology |
| 1982 | 82-054 | 18 Oct | 15 | F. Mauger | H. Josenhans, BIO | Labrador Shelf | Geology |
| 1982 | 82-038 | 2 Nov | 25 | F. Mauger | J. Lazier, BIO | Labrador Sea | Physics |
| 1983 | 83-002 | 6 Apr | 17 | F. Mauger | T. Platt, BIO | Sargasso Sea | Chemistry Biology |
| 1983 | 83-007 | 23 Apr | 9 | F. Mauger | R. Ryall, DAL | Sargasso Sea | Engineering Geology Biology |
| 1983 | 83-009 | 4 May | 23 | F. Mauger | R. Hendry, BIO | Northwest Atlantic Gulf Stream | Geophysics Physics Chemistry |
| 1983 | 83-017 Leg 1 | 7 Jun | 14 | F. Mauger | K. Manchester, BIO | Scotian Shelf Laurentian Fan Grand Banks | Geophysics Geology Physics |
| 1983 | 83-017 Leg 2 | 22 Jun | 13 | F. Mauger | B. Loncarevic, BIO | Scotian Shelf Laurentian Fan Grand Banks | Geophysics Geology Physics |
| 1983 | 83-019 | 8 Jul | 7 | L. Strum | G. Fader, BIO | Scotian Shelf | Engineering Geology |
| 1983 | 83-021 | 28 Jul | 9 | F. Mauger | J. Lazier, BIO | Labrador Sea | Physics |
| 1983 | 83-023 | 6 Aug | 42 | F. Mauger | T. Platt, BIO | Baffin Bay Jones Sound Kane Basin Lancaster Sound | Physics Chemistry Biology |
| 1983 | 83-028 | 19 Sep | 16 | F. Mauger | J. Syvitski, BIO C. Schafer, BIO | Baffin Island Fjords | Geophysics Geology Ecology |
| 1983 | 83-030 | 6 Oct | 19 | F. Mauger | G. Vilks, BIO | Labrador Shelf Lake Melville | Geology Chemistry |
| 1983 | 83-033 | 28 Oct | 11 | F. Mauger | G. Vilks, BIO | Grand Banks | Geology |
| 1983 | 83-036 | 9 Nov | 28 | F. Mauger | J. Lazier, BIO | Hamilton Bank | Physics |
| 1983 | 83-043 | 7 Dec | 6 | F. Mauger | A. Hay, MUN | Fortune Bay Baie D'Espair Hermitage Channel | Geophysics Physics |
| 1984 | 84-001 | 24 Jan | 11 | F. Mauger | G. Bugden, BIO | Gulf of St. Lawrence | Physics Chemistry Biology |
| 1984 | 84-010 | 9 Apr | 10 | F. Mauger | T. Platt, BIO | Grand Banks | Biology |
| 1984 | 84-012 | 27 Apr | 19 | F. Mauger | R. Hendry, BIO | Gulf Stream | Physics |
| 1984 | 84-021 | 25 May | 20 | F. Mauger | C. Keen, BIO | Grand Banks Continental Margin | Geophysics |
| 1984 | 84-024 | 18 Jun | 4 | F. Mauger | M. Lewis, BIO | Avalon Channel | Geophysics Geology |
| 1984 | 84-026 | 22 Jun | 14 | F. Mauger | J. Lazier, BIO | Hamilton Bank | Physics Biology |
| 1984 | 84-029 | 18 Jul | 7 | F. Mauger | G. Fader, BIO | Scotia Shelf Scotian Slope | Geology |
| 1984 | 84-030 | 27 Jul | 30 | R. Dickinson | S. Srivastava, BIO | Labrador Sea | Geophysics Geology |
| 1984 | 84-035 Leg 1 | 29 Aug | 14 | F. Mauger | C. Schafer, BIO | Flemish Pass Labrador Shelf Labrador Slope | Geology |
| 1984 | 84-035 Leg 2 | 11 Sept | 17 | F. Mauger | B. MacLean, BIO | Labrador Shelf Labrador Slope Baffin Island | Geology |
| 1984 | 84-038 | 28 Sep | 6 | F. Mauger | J. Lazier, BIO | Lake Melville Hamilton Bank | Physics |
| 1984 | 84-040 | 6 Oct | 17 | F. Mauger | D. Piper, BIO | Laurentian Fan Scotian Slope | Geology |
| 1984 | 84-045 | 30 Oct | 10 | F. Mauger | P. Ryall, DAL | Sargasso Sea | Engineering Geology |
| 1984 | 84-046 | 10 Nov | 19 | F. Mauger | D. Buckley, BIO | Bermuda Rise Nares Abyssal Plain | Geology Chemistry Biology |
| 1984 | 84-049 | 1 Dec | 17 | F. Mauger | T. Platt, BIO | Caribbean Sea US East Coast | Biology |
| 1985 | 85-001 | 18 Mar | 11 | F. Mauger | D. Piper, BIO | Scotian Slope Laurentian Fan | Geology |
| 1985 | 85-005 | 31 Mar | 16 | F. Mauger | G. Fader, BIO | Grand Banks | Geophysics |

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| 1985 | Leg 1 85-005 | 16 Apr | 8 | F. Mauger | G. Fader, BIO | Grand Banks | Geology Geology |
| 1985 | Leg 2 85-010 | 30 Apr | 29 | F. Mauger | L. Mayer, DAL | Mid Atlantic Ridge | Geophysics |
| 1985 | 85-014 | 30 May | 28 | F. Mauger | N. Oakey, BIO | Canary Basin | Physics Biology |
| 1985 | 85-018 | 30 Jun | 14 | F. Mauger | J. Lazier, BIO | Labrador Shelf | Physics Biology |
| 1985 | 85-020 | 22 Jul | 22 | ??? | G. Harrison, BIO | Browns Bank Georges Bank Sargasso Sea | Physics Biology |
| 1985 | 85-025 | 19 Aug | 13 | R. Dickinson | I. Reid, BIO | Flemish Cap | Geophysics |
| 1985 | 85-031 | 03 Sep | 20 | F. Mauger | K. Drinkwater, BIO | Ungava Bay Labrador Shelf | Biology |
| 1985 | 85-027 | 23 Sep | 34 | F. Mauger | B. MacLean, BIO | Davis Strait Baffin Bay Hudson Strait | Geology |
| 1985 | 85-034 | 30 Oct | 14 | F. Mauger | K. Louden, DAL | Labrador Sea | Geophysics |
| 1985 | 85-044 | 14 Nov | 7 | F. Mauger | K. Manchester, BIO | Flemish Pass | Geology |
| 1986 | 86-006 | 17 Apr | 19 | F. Mauger | A. Clarke, BIO | Newfoundland Basin | Physics |
| 1986 | Leg 1 86-006 | 6 May | 14 | F. Mauger | A. Clarke, BIO | Newfoundland Basin | Chemistry Physics |
| 1986 | Leg 2 86-013 | 27 May | 18 | F. Mauger | I. Reid, BIO | Orphan Basin Orphan Margin | Chemistry Geophysics |
| 1986 | 86-017 | 19 Jun | 9 | J. Lewis | G. Fader, BIO | Grand Banks | Geology |
| 1986 | 86-018 | 2 July | 12 | J. Lewis | R. Parrott, BIO | Grand Banks Flemish Pass | Geology |
| 1986 | 86-021 | 24 Jul | 13 | F. Mauger | J. Lazier, BIO | Labrador Shelf | Physics |
| 1986 | Leg 1 86-021 | 7 Aug | 19 | F. Mauger | C. Ross, BIO | Labrador Sea Nain Bank | Physics |
| 1986 | Leg 2 86-027 | 26 Aug | 31 | F. Mauger | B. MacLean, BIO | Labrador Sea Baffin Bay | Chemistry |
| 1986 | 86-029 | 27 Sep | 8 | F. Mauger | K. Drinkwater, BIO | Arctic Islands Hudson Strait | Geology Physics |
| 1986 | 86-040 | 5 Oct | 16 | ??? | H. Josenhans, BIO | Ungava Bay Hudson Bay | Geology |
| 1986 | Leg 1 86-040 | 21 Oct | 15 | ??? | C. Schafer, BIO | Labrador Sea | Geology |
| 1986 | Leg 2 86-034 | 4 Nov | 12 | F. Mauger | D. Piper, BIO | Newfoundland Slope | Geology |
| 1987 | 87-003 | 3 Apr | 11 | L. Strum | K. Manchester, BIO | Scotian Slope Scotian Shelf Scotian Slope | Geophysics |
| 1987 | 87-008 | 21 Apr | 16 | L. Strum | D. Piper, BIO | Laurentian Fan Grand Banks Fogo Seamounts | Geology Chemistry |
| 1987 | 87-014 | 7 May | 7 | L. Strum | G. Fader, BIO | Laurentian Fan Grand Banks | Geology |
| 1987 | 87-019 | 16 May | 22 | L. Strum | C. Keen, BIO | Grand Banks | Geophysics |
| 1987 | 87-022 | 11 Jun | 28 | ??? | T. Platt, BIO | North Atlantic | Biology |
| 1987 | 87-025 | 16 Jul | 18 | ??? | K. Louden, DAL | Labrador Basin | Geophysics |
| 1987 | 87-028 | 3 Aug | 18 | L. Strum | H. Josenhans, BIO | Hudson Bay | Geology |
| 1987 | 87-031 | 23 Aug | 25 | L. Strum | C. Ross, BIO | Hudson Bay Hudson Strait Davis Strait | Geophysics Physics |
| 1987 | 87-033 | 18 Sep | 20 | L. Strum | G. Vilks, BIO | Baffin Bay Davis Strait Baffin Bay | Geology |
| 1987 | 87-037 | 9 Oct | 25 | L. Strum | A. Clarke, BIO | Hudson Strait Labrador Sea | Physics |
| 1988 | 88-000 | 23 Mar | 2 | L. Strum | A. Clarke, BIO | Newfoundland Basin Grand Banks | Physics |
| 1988 | 88-001 | 19 Apr | 15 | L. Strum | R. Hendry, BIO | Laurentian Channel Scotian Shelf | Physics |
| 1988 | 88-014 | 5 May | 15 | L. Strum | T. Platt, BIO | North Atlantic off the Grand Banks Labrador Shelf Strait of Belle Isle Scotian Shelf | Physics Biology |

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| 1988 | 88-010 | 24 May | 15 | L. Strum | D. Piper, BIO | Scotian Shelf Scotian Slope | Geology |
| 1988 | 88-020 | 15 Jun | 13 | L. Strum | B. Loncarevic, BIO | Scotian Shelf | Geophysics |
| 1988 | 88-022 | 30 Jun | 20 | F. Mauger | I. Reid, BIO | Gulf of St. Lawrence | Geophysics |
| 1988 | 88-024 | 21 Jul | 20 | F. Mauger | K. Louden, DAL | Labrador Sea | Geophysics |
| 1988 | 88-026 | 15 Aug | 16 | L. Strum | G. Harrison, BIO | Georges Bank | Biology |
| 1988 | 88-026 Leg 1 | 7 Sep | 14 | L. Strum | G. Harrison, BIO | Sargasso Sea | Biology |
| 1988 | 88-026 Leg 2 | 7 Sep | 14 | L. Strum | G. Harrison, BIO | Sargasso Sea | Biology |
| 1989 | 89-030 | 21 Nov | 11 | L. Strum | P. Mudie, BIO | Newfoundland Slope Newfoundland Basin | Geology |
| 1989 | 89-033 | 1 Dec | 16 | L. Strum | C. Hillaire-Marcel, UQAM | Labrador Sea | Geophysics |
| 1990 | 89-037 | 2 Jan | 27 | L. Strum | R. Hendry, BIO | Newfoundland Basin | Physics |
| 1990 | 89-038 | 19 Feb | 20 | L. Strum | K. Moran, BIO | Bermuda Rise | Geology |
| 1990 | 89-039 | 14 Mar | 16 | L. Strum | C. Amos, BIO | Baltimore Canyon Georges Bank | Geology Biology |
| 1990 | 90-001 | 5 Apr | 25 | L. Strum | T. Platt, BIO | Northwest Atlantic | Biology |
| 1990 | 90-007 | 7 May | 20 | L. Strum | P. Mudie, BIO | Newfoundland Basin | Geology |
| 1990 | 90-013 | 29 May | 24 | L. Strum | C. Hillaire-Marcel, UQAM | Labrador Sea Newfoundland Coast | Geophysics |
| 1990 | 90-015 | 10 Jul | 21 | L. Strum | D. Piper, BIO | St. Pierre Slope Verrill Canyon | Geology |
| 1990 | 90-019 | 10 Aug | 17 | L. Strum | I. Reid, BIO | Labrador Sea | Geophysics |
| 1990 | 90-022 | 31 Aug | 18 | L. Strum | C. Ross, BIO | Davis Strait Baffin Bay | Physics |
| 1990 | 90-023 | 18 Sep | 35 | L. Strum | B. MacLean, BIO | Frobisher Bay Hudson Strait Ungava Bay Labrador Slope | Geology |
| 1990 | 90-028 | 30 Oct | 18 | L. Strum | H. Josenhans, BIO | Gulf St. Lawrence | Geology |
| 1990 | 90-031 | 19 Nov | 18 | L. Strum | G. Vilks, BIO | Gulf of St. Lawrence Cabot Strait Laurentian Channel | Geology |
| 1991 | 91-001 | 3 Apr | 17 | L. Strum | G. Harrison, BIO | Northwest Atlantic | Biology |
| 1991 | 91-007 Leg 1 | 24 Apr | 31 | L. Strum | R. Hendry, BIO | Northwest Atlantic Labrador Sea | Physics Chemistry Biology |
| 1991 | 91-007 Leg 2 | 26 May | 9 | L. Strum | R. Hendry, BIO | Northwest Atlantic Labrador Sea | Physics Chemistry Biology |
| 1991 | 91-020 | 11 Jun | 23 | L. Strum | D. Piper, BIO | Slope Fogo Seamounts Flemish Cap | Geology |
| 1991 | 91-027 | 6 Jul | 20 | J. Lewis | F. Marillier, DAL | Grand Banks Cabot Strait | Geophysics |
| 1991 | 91-039 | 15 Aug | 36 | L. Strum | R. Jackson, BIO | Baffin Bay Nares Strait | Geophysics |
| 1991 | 91-033 | 22 Sep | 20 | L. Strum | J. Syvitsky, BIO | Lake Melville | Geophysics |
| 1991 | 91-045 Leg 1 | 14 Oct | 25 | L. Strum | C. Hillaire-Marcel, UQAM | Labrador Sea | Geology |
| 1991 | 91-045 Leg 2 | ??? | ??? | L. Strum | C. Hillaire-Marcel, UQAM | Irminger Basin Iceland Basin | Geology |
| 1991 | 91-055 | 10 Nov | 16 | L. Strum | F. Dobson, BIO | Grand Banks | Physics |
| 1991 | 91-059 | 28 Nov | 13 | L. Strum | P. Smith, BIO | Grand Banks Labrador Sea | Physics |
| 1992 | 91-061 | 12 Mar | 22 | L. Strum | C. Tang, BIO | Newfoundland Shelf | Physics |
| 1992 | 92-001 | 6 Apr | 10 | L. Strum | C. Amos, BIO | Scotian Shelf | Geology |
| 1992 | 92-003 | 21 Apr | 11 | L. Strum | D. Buckley, BIO | Scotian Shelf Scotian Slope | Geology |
| 1992 | 92-010 | 8 May | 17 | L. Strum | P. Smith, BIO | Grand Banks Labrador Sea | Physics |
| 1992 | 92-014 | 27 May | 18 | ??? | J. Lazier, BIO | Labrador Sea | Physics |
| 1992 | 92-022 | 29 Jun | 32 | ??? | S. Srivastava, BIO | Flemish Cap Newfoundland Basin | Geophysics |
| 1992 | 92-028 Leg 1 | 5 Aug | 25 | F. Berchem | C. Amos, BIO | Hudson Bay | Geology |
| 1992 | 92-028 | 31 Aug | 12 | F. Berchem | B. MacLean, BIO | Hudson Bay | Geology |

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|------|-----------------|---------|-----|---------------|--------------------|---|--|
| 1992 | Leg 2 92-037 | 16 Sep | 35 | ??? | G. Harrison, BIO | Hudson Strait North Atlantic Moroccan Coast | Biology |
| 1992 | 92-045 | 26 Oct | 25 | ??? | R. Hess, McG | Labrador Slope Flemish Cap | Geology |
| 1992 | 92-050 | 24 Nov | 8 | L. Strum | R. Lively, BIO | Gulf of St. Lawrence | Physics |
| 1992 | 92-051 | 6 Dec | 13 | ??? | B. Klein, GIROQ | Gulf of St. Lawrence | Biology |
| 1993 | 93-053 | 5 Apr | 39 | L. Strum | N. Oakey, BIO | Canary Basin | Physics |
| 1993 | 93-002 | 15 May | 24 | L. Strum | G. Harrison, BIO | Off Northwest Africa | Biology |
| 1993 | 93-016 | 10 Jun | 6 | L. Strum | C. Amos, BIO | Sable Island Bank | Geology |
| 1993 | 93-019 | 17 Jun | 12 | L. Strum | J. Lazier, BIO | Labrador Sea | Physics |
| 1993 | 93-027 | 8 Aug | 25 | L. Strum | P. Yeats, BIO | North Atlantic Greenland Sea Norwegian Sea | Chemistry |
| 1993 | 93-030 | 3 Sep | 14 | L. Strum | J. Syvitsky, BIO | Greenland fjords | Geophysics Geology |
| 1993 | 93-034 | ??? Oct | ??? | J. Lewis | B. MacLean, BIO | Hudson Strait Ungava Bay | Geology |
| 1993 | 93-039 | 15 Nov | 32 | J. Lewis | A. Clarke, BIO | Newfoundland Basin | Physics |
| 1994 | 94-002 | 2 May | 11 | J. Lewis | E. Colbourne, NAFC | Grand Banks | Physics Chemistry Biology |
| 1994 | 94-008 | 24 May | 19 | ??? | J. Lazier, BIO | Labrador Sea | Physics Biology |
| 1994 | 94-016 | 13 Jun | 17 | J. Lewis | B. Klein, LVL | Gulf of St. Lawrence Cabot Strait | Biology |
| 1994 | 94-017 | 4 Jul | 18 | J. Dockrill | S. Narayanan, NAFC | Scotian Shelf Newfoundland Shelf Labrador Shelf | Physics |
| 1994 | 94-027 | 15 Aug | 18 | J. Dockrill | A. Grant, BIO | Laurentian Channel | Geology |
| 1994 | 94-021 | 6 Sep | 16 | J. Dockrill | G. Sonnichsen, BIO | Grand Banks | Geology |
| | Leg 1 94-021 | 22 Sep | 15 | J. Dockrill | W. MacKinnon, BIO | Emerald Basin | Geology |
| | Leg 2 94-030 | 12 Oct | 29 | J. Dockrill | A. Clarke, BIO | Newfoundland Basin | Physics |
| 1995 | 95-003 | 19 Apr | 28 | A. Croft | A. Clarke, BIO | Newfoundland Basin | Physics Chemistry |
| 1995 | 95-006 | 23 May | 11 | A. Croft | H. Josenhans, BIO | Cabot Strait Cape Breton Channel | Geology |
| 1995 | 95-011 | 7 Jun | 28 | A. Croft | J. Lazier, BIO | Labrador Sea North Atlantic | Physics |
| 1995 | 95-016 | 6 Jul | 16 | A. Croft | G. Harrison, BIO | Newfoundland Shelf Labrador Sea North Atlantic Scotian Shelf | Biology |
| 1995 | 95-020 | 9 Aug | 58 | R. Smith | P. Davies, CHS | Rankin Inlet | Hydrography |
| 1995 | 95-030 | 12 Oct | 18 | R. Smith | G. Fader, BIO | Bay of Fundy Gulf of Maine Scotian Shelf | Geology |
| 1995 | 95-030 | 31 Oct | 10 | R. Smith | R. Courtney, BIO | Emerald Basin | Geology |
| 1995 | 95-033 | 21 Nov | 18 | A. Croft | D. Piper, BIO | Laurentian Fan Sable Island Bank | Geology |
| 1996 | 96-006 | 10 May | 23 | L. Rhodenizer | J. Lazier, BIO | Labrador Sea | Physics |
| 1996 | 96-010 | 5 Jun | 16 | L. Rhodenizer | M. Mitchell, BIO | Scotian Shelf Cabot Strait | Physics Chemistry |
| 1996 | 96-014 | 22 Jun | 6 | L. Rhodenizer | G. Bugden, BIO | Laurentian Channel Gulf of St. Lawrence St. Pierre Bank Scotian Shelf | Biology Physics Chemistry Biology |
| 1996 | 96-016 | 16 Jul | 53 | L. Rhodenizer | P. Davies, CHS | Rankin Inlet Hudson Bay | Hydrography |
| 1996 | 96-021 | 9 Sep | 29 | L. Rhodenizer | I. Reid, BIO | Ungava Bay Labrador Coast | Geophysics |
| 1996 | 96-026 | 15 Oct | 36 | L. Rhodenizer | A. Clarke, BIO | Labrador Sea | Physics |
| 1996 | 96-029 | 25 Nov | 12 | L. Rhodenizer | C. Amos, BIO | Sable Island Bank Laurentian Fan | Geology |
| 1997 | 97-001 | 8 Apr | 7 | L. Rhodenizer | C. Amos, BIO | Sable Island Bank | Geology |
| 1997 | 97-003 | 17 Apr | 18 | L. Rhodenizer | E. Head, BIO | Scotian Shelf | Physics |

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|------|-----------------|--------|----|-----------------------------|---------------------|--|---|
| 1997 | 97-009 | 9 May | 34 | D. Shea | A. Clarke, BIO | Cabot Strait St. Pierre Bank Scotian Shelf Labrador Sea | Chemistry Biology Physics Chemistry Biology |
| 1997 | 97-020 | 16 Jun | 18 | D. Shea | G. Fader, BIO | Bay of Fundy Browns Bank | Geology Biology |
| 1997 | 97-033 Leg 1 | 18 Jul | 24 | D. Shea | P. Davies, CHS | Chesterfield Inlet Chesterfield Narrows | Hydrography |
| 1997 | 97-033 Leg 2 | | 31 | L. Rhodenizer | P. Davies, CHS | Whale Cove Arivat | Hydrography |
| 1997 | 97-048 | 14 Sep | 20 | D. Shea | D. Piper, BIO | Hudson Strait Labrador Sea | Geology |
| 1997 | 97-058 | 11 Oct | 12 | L. Rhodenizer | H. Josenhans, BIO | Cape Breton Area Gulf of St. Lawrence | Geology |
| 1997 | 97-063 | 25 Oct | 16 | J. Dockrill | M. Mitchell, BIO | Scotian Shelf Cabot Strait | Physics Chemistry Biology |
| 1997 | 97-069 | 17 Nov | 19 | D. Shea | F. Dobson, BIO | Grand Banks | Physics |
| 1998 | 98-001 | 23 Mar | 11 | M. Marsden | C. Amos , BIO | Sable Island Bank | Geology |
| 1998 | 98-002 Leg 1 | 7 Apr | 6 | L. Rhodenizer | E. Head, BIO | Scotian Shelf Cabot Strait | Biology |
| 1998 | 98-002 Leg 2 | 13 Apr | 15 | L. Rhodenizer | D. Sameoto, BIO | Scotian Shelf Cabot Strait | Biology |
| 1998 | 98-006 | 1 May | 17 | M. Marsden | M. Levasseur, IML | Northwest Atlantic | Biology |
| 1998 | 98-015 Leg 1 | 22 May | 11 | L. Rhodenizer | D. Gordon, BIO | Scotian Shelf | Biology |
| 1998 | 98-015 Leg 2 | 2 June | 14 | L. Rhodenizer | K. Muschenheim, BIO | Grand Banks | Biology |
| 1998 | 98-023 | 22 Jun | 18 | M. Marsden | P. Jones, BIO | Scotian Shelf Labrador Sea | Physics Chemistry Biology |
| 1998 | 98-034 | 29 Jul | 11 | L. Rhodenizer | G. Sonnichsen, BIO | Grand Banks Flemish Pass | Geology |
| 1998 | 98-039 | 7 Aug | 12 | L. Rhodenizer | D. Piper, BIO | Newfoundland Ridge Scotian Slope | Geology |
| 1998 | 98-042 | 23 Aug | 12 | M. Marsden | R. Jackson, BIO | Scotian Shelf | Geophysics |
| 1998 | 98-047 | 7 Sep | 10 | M. Marsden | G. Bugden, BIO | Grand Banks St. Pierre Bank | Physics |
| 1998 | 98-050 | 2 Oct | 17 | L. Rhodenizer M. Marsden | A. Herman, BIO | Cabot Strait Scotian Shelf | Physics Chemistry Biology |
| 1998 | 98-069 Leg 1 | 23 Oct | 11 | M. Marsden | P. Larouche, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 1998 | 98-069 Leg 2 | 3 Nov | 12 | M. Marsden | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 1998 | 98-077 | 20 Nov | 6 | L. Rhodenizer | P. Smith, BIO | Scotian Shelf Northeast Channel Georges Bank | Physics Biology |
| 1999 | 99-001 Leg 1 | 1 Apr | 6 | L. Rhodenizer | M. Mitchell, BIO | Scotian Shelf Cabot Strait | Physics Biology |
| 1999 | 99-001 Leg 2 | 7 Apr | 11 | M. Marsden | E. Horne, BIO | Cabot Strait Scotian Shelf | Physics Biology |
| 1999 | 99-007 | 21 Apr | 15 | M. Marsden | R. Jackson, BIO | Scotian Shelf | Geophysics |
| 1999 | 99-012 Leg 1 | 12 May | 10 | J. McKenna | D. Gordon, BIO | Scotian Shelf | Geology Biology |
| 1999 | 99-012 Leg 2 | 22 May | 15 | J. McKenna | K. Muschenheim, BIO | Grand Banks | Geology Biology |
| 1999 | 99-018 | 10 Jun | 13 | M. Marsden | G. Bugden, BIO | Scotian Shelf Grand Banks | Physics |
| 1999 | 99-022 | 27 Jun | 17 | J. McKenna | A. Clarke, BIO | Scotian Shelf Labrador Sea | Physics Chemistry Biology |
| 1999 | 99-031 | 3 Aug | 15 | J. McKenna | G. Sonnichsen, BIO | Grand Banks Flemish Pass | Geology |
| 1999 | 99-036 | 19 Aug | 20 | M. Marsden | D. Piper, BIO | Laurentian Channel Scotian Slope | Geology |
| 1999 | 99-043 | 10 Sep | 22 | J. McKenna | M. Levasseur, IML | Northwest Atlantic | Biology |
| 1999 | 99-049 | 5 Oct | 15 | M. Marsden | D. Forbes, BIO | North Shore PEI | Geology |

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|------|-------------------|--------|----|---------------|--------------------|---|-----------------------------------|
| 1999 | 99-054 Leg 1 | 23 Oct | 13 | J. McKenna | E. Head, BIO | Northumberland Strait Cabot Strait | Physics Biology |
| 1999 | 99-054 Leg 2 | 6 Nov | 7 | J. McKenna | M. Mitchell, BIO | Scotian Shelf Cabot Strait Scotian Shelf | Physics Biology Engineering |
| 1999 | 99-061 | 15 Nov | 14 | M. Marsden | E. Colbourne, NAFC | Grand Banks | Physics Biology |
| 1999 | 99-063 | 1 Dec | 14 | M. Marsden | A. Gagne, IML | Gulf of St. Lawrence Scotian Shelf | Physics Biology |
| 2000 | 2000-009 | 20 May | 18 | L. Rhodenizer | G. Harrison, BIO | Labrador Sea | Physics Chemistry Biology |
| 2000 | 2000-020 Leg 1 | 11 Jun | 13 | M. Marsden | K. Mushenheim, BIO | Scotian Shelf Grand Banks | Biology |
| 2000 | 2000-020 Leg 2 | 25 Jun | 12 | M. Marsden | D. Gordon, BIO | Scotian Shelf Northeast Channel | Biology |
| 2000 | 2000-030 Leg 1 | 13 Jul | 8 | L. Rhodenizer | M. Li, BIO | Scotian Shelf | Geology |
| 2000 | 2000-030 Leg 2 | 21 Jul | 5 | L. Rhodenizer | J. Shaw, BIO | Gulf of St. Lawrence | Geology |
| 2000 | 2000-030 Leg 3 | 25 Jul | 3 | L. Rhodenizer | H. Josenhans, BIO | Gulf of St. Lawrence | Geology |
| 2000 | 2000-030 Leg 4 | 28 Jul | 4 | L. Rhodenizer | D. Forbes, BIO | Gulf of St. Lawrence | Geology |
| 2000 | 2000-036 | 3 Aug | 15 | L. Rhodenizer | D. Piper, BIO | Scotian Shelf Scotian Slope | Geology |
| 2000 | 2000-042 | 21 Aug | 17 | M. Marsden | D. Mosher, BIO | Scotian Slope | Geology |
| 2000 | 2000-047 | 9 Sep | 14 | R. Smith | B. Todd, BIO | Scotian Shelf Northeast Channel Georges Bank Cabot Strait Scotian Shelf | Geology |
| 2000 | 2000-050 Leg 1 | 30 Sep | 16 | L. Rhodenizer | E. Home, BIO | Cabot Strait Scotian Shelf | Physics Chemistry Biology |
| 2000 | 2000-050 Leg 2 | 16 Oct | 9 | L. Rhodenizer | M. Mitchell, BIO | Cabot Strait Scotian Shelf | Physics Chemistry Biology |
| 2000 | 2000-060 | 29 Oct | 15 | M. Marsden | E. Colbourne, NAFC | Grand Banks | Physics Chemistry Biology |
| 2000 | 2000-066 | 16 Nov | 7 | W. English | G. Bugden, BIO | Scotian Shelf St. Pierre Bank | Physics |
| 2000 | 2000-068 | 27 Nov | 12 | L. Rhodenizer | A. Gagné, IML | Gulf of St. Lawrence, | Physics Chemistry Biology |
| 2001 | 2001-009 Leg 1 | 1 May | 16 | M. Champagne | E. Head, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2001 | 2001-009 Leg 2 | 17 May | 8 | M. Champagne | M. Mitchell, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2001 | 2001-022 | 30 May | 16 | ??? | A. Clarke, BIO | Scotian Shelf Labrador Sea | Physics Chemistry Biology |
| 2001 | 2001-028 | 20 Jun | 21 | M. Champagne | R. Jackson, BIO | Scotian Shelf | Geophysics |
| 2001 | 2001-038 Leg 1 | 18 Jul | 9 | R. Smith | G. Sonnichsen, BIO | Grand Banks | Geology |
| 2001 | 2001-038 Leg 2 | 27 Jul | 9 | R. Smith | G. Sonnichsen, BIO | Grand Banks | Geology |
| 2001 | 2001-043 | 5 Aug | 14 | R. Smith | D. Piper, BIO | Grand Banks, Flemish Pass St. Pierre Slope Scotian Shelf | Geology |
| 2001 | 2001-048 Leg 1 | 26 Aug | 10 | M. Champagne | D. Mosher | Scotian Shelf Scotian Slope | Geology |
| 2001 | 2001-048 Leg 2 | 5 Sep | 7 | M. Champagne | B. Todd | Scotian Shelf Gulf of Maine Georges Bank Scotian Shelf | Geology |
| 2001 | 2001-055 | 18 Sep | 8 | ??? | D. Gordon, BIO | Scotian Shelf | Biology |

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|------|-------------------|--------|----|--------------|--------------------|---|--|
| 2001 | | 26 Sep | 11 | ??? | D. Gordon, BIO | Scotian Shelf Scotian Slope Northeast Channel Georges Bank | Biology |
| 2001 | 2001-061 Leg 1 | 14 Oct | 9 | M. Champagne | M. Mitchell, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2001 | 2001-061 Leg 2 | 23 Oct | 16 | M. Champagne | E. Horne, BIO | Cabot Strait Laurentian Channel | Physics Chemistry |
| 2001 | 2001-068 | 12 Nov | 15 | ??? | E. Colbourne, NAFC | Scotian Shelf Grand Banks Flemish Cap | Biology Physics Chemistry |
| 2001 | 2001-072 | 28 Nov | 11 | R. Smith | A. Gagné, IML | Newfoundland Shelf Gulf of St. Lawrence, | Biology Physics Chemistry Biology |
| 2002 | 2002-011 | 3 May | 16 | M. Hemeon | K. Loudon, DAL | Grand Bank Flemish Cap | Geophysics |
| 2002 | 2002-026 | 3 Jun | 13 | R. Ashton | B. Todd, BIO | Scotian Shelf Gulf of Maine Georges Bank | Geology |
| 2002 | 2002-032 | 23 Jun | 16 | ??? | A. Clarke, BIO | Scotian Shelf Grand Banks Labrador Sea | Physics Chemistry Biology |
| 2002 | 2002-021 | 3 Aug | 10 | R. Ashton | B. Miller, BIO | Scotian Shelf Scotian Slope | Geology |
| 2002 | 2002-046 | 15 Aug | 21 | M. Hemeon | D. Piper, BIO | Scotian Shelf Scotian Slope Laurentian Fan | Geology |
| 2002 | 2002-054 Leg 1 | 10 Sep | 10 | R. Ashton | D. Gordon, BIO | Grand Banks Scotian Shelf | Biology |
| 2002 | 2002-054 Leg 2 | 20 Sep | 13 | R. Ashton | D. Gordon, BIO | Laurentian Channel Scotian Shelf | Biology |
| 2002 | 2002-054 Leg 3 | 3 Oct | 1 | R. Ashton | B. Greenan, BIO | Halifax Harbour Approaches | Physics |
| 2002 | 2002-064 Leg 1 | 10 Oct | 7 | M. Hemeon | M. Mitchell, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2002 | 2002-064 Leg 2 | 17 Oct | 14 | M. Hemeon | E. Horne, BIO | Cabot Strait Laurentian Channel | Physics Chemistry Biology |
| 2002 | 2002-070 | 7 Nov | 15 | R. Ashton | E. Colbourne, NAFC | Scotian Shelf Grand Banks St. Pierre Bank Flemish Cap | Physics Chemistry Biology |
| 2002 | 2002-073 | 23 Nov | 5 | R. Ashton | M. Scotney, BIO | Newfoundland Shelf Labrador Shelf Grand Bank | Physics |
| 2002 | 2002-075 | 29 Nov | 13 | ??? | E. Head, BIO | Flemish Pass Labrador Sea | Physics Chemistry Biology |
| 2003 | 2003-005 | 12 Apr | 7 | M. Hemeon | E. Head, BIO | Scotian Shelf Scotian Slope | Biology |
| 2003 | 2003-010 | 23 Apr | 25 | R. Ashton | W. Miller, DAL | Northwest Atlantic | Chemistry |
| 2003 | 2003-021 | 21 May | 8 | M. Hemeon | M. Mitchell, BIO | Cabot Strait Scotian Shelf | Physics Chemistry Biology |
| 2003 | 2003-029 | 3 Jun | 10 | M. Hemeon | V. Kostylev, BIO | Scotian Shelf | Geology |
| 2003 | 2003-033 | 15 Jun | 21 | R. Ashton | D. Piper, BIO | Laurentian Channel Scotian Shelf Scotian Slope Laurentian Fan | Geology |
| 2003 | 2003-038 | 13 Jul | 22 | ??? | A. Clarke, BIO | Grand Banks Orphan Basin Scotian Shelf | Physics Chemistry Biology |
| 2003 | 2003-047 | 10 Aug | 23 | ??? | R. Jackson, BIO | Grand Banks Labrador Sea | Geophysics |
| 2003 | 2003-054 | 7 Sep | 15 | M. Hemeon | B. Todd, BIO | Davis Strait Scotian Shelf | Geology |
| 2003 | 2003-059 | 25 Sep | 8 | M. Hemeon | D. Gordon, BIO | Gulf of Maine Scotian Shelf | Biology |

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| 2003 | Leg 1 2003-059 Leg 2 | 3 Oct | 12 | R. Ashton | D. McKeown, BIO | Scotian Shelf | Biology |
| 2003 | 2003-072 Leg 1 | 1 Nov | 6 | R. Ashton | M. Mitchell, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2003 | 2003-072 Leg 2 | 7 Nov | 7 | R. Ashton | E. Home, BIO | Cabot Strait Laurentian Channel Scotian Shelf | Physics Chemistry Biology |
| 2003 | 2003-075 Leg 1 | 16 Nov | 12 | M. Hemeon | E. Colbourne, NAFC | Grand Banks Flemish Cap | Physics Chemistry Biology |
| 2003 | 2003-075 Leg 2 | 28 Nov | 8 | R. Ashton | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2003 | 2003-078 | 8 Dec | 14 | R. Ashton | E. Head, BIO | Grand Banks, Laurentian Fan Scotian Shelf | Biology |
| 2004 | 2004-005 | 5 Apr | 4 | D. Martin | M. Scotney, BIO | Scotian Shelf Scotian Slope | Physics |
| 2004 | 2004-009 Leg 1 | 18 Apr | 8 | M. Rothwell | E. Home, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2004 | 2004-009 Leg 2 | 26 Apr | 13 | M. Rothwell | E. Home, BIO | Scotian Shelf Cabot Strait St. Pierre Bank Grand Banks | Physics Chemistry Biology |
| 2004 | 2004-016 | 15 May | 15 | ??? | G. Harrison, BIO | Scotian Shelf Labrador Sea | Physics Chemistry Biology |
| 2004 | 2004-019 | 31 May | 10 | D. Martin | I. Yashayaev, BIO | Orphan Basin Flemish Pass Laurentian Fan Scotian Shelf | Physics |
| 2004 | 2004-024 | 17 Jun | 21 | M. Rothwell | D. Piper, BIO | St. Pierre Slope Grand Banks Flemish Pass Orphan Knoll | Geology |
| 2004 | 2004-030 | 10 Jul | 10 | D. Martin | D. Mosher, BIO | Laurentian Channel, Scotian Shelf Scotian Slope | Geology |
| 2004 | 2004-037 | 22 Jul | 10 | M. Hemeon | M. Li, BIO | Sable Island Bank | Geology |
| 2004 | 2004-038 Leg 1 | 2 Aug | 15 | ??? | B. Morin, IML | Gulf of St. Lawrence Cabot Strait | ??? |
| 2004 | 2004-038 Leg 2 | 17 Aug | 14 | ??? | D. Archambault, IML | Gulf of St. Lawrence Cabot Strait | ??? |
| 2004 | 2004-055 | 19 Oct | 8 | M. Rothwell | E. Head, BIO | Cabot Strait Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2004 | 2004-061 | 1 Nov | 14 | D. Martin | A. Gagne, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2004 | 2004-065 Leg 1 | 17 Nov | 9 | D. Martin | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2004 | 2004-065 Leg 2 | | 7 | M. Rothwell | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2005 | 2005-012 | 17 May | 9 | P. Bragg | I. Yashayaev, BIO | Flemish Pass Orphan Basin | Physics |
| 2005 | 2005-016 | 26 May | 11 | P. Bragg | G. Harrison, BIO | Labrador Sea | Physics Chemistry Biology |
| 2005 | 2005-021 | 10 Jun | 7 | P. Bragg | E. Head, BIO | Gulf of Maine | Biology |
| 2005 | 2005-023 | 18 Jun | 8 | D. Martin | E. King, BIO | Northeast Channel Scotian Slope | Geology |

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| 2005 | 2005-028 | 27 Jun | 10 | D. Martin | K. Lee, BIO | Grand Banks | Chemistry Biology Geology |
| 2005 | 2005-033 Leg 1 | 16 Jul | 5 | D. Martin | M. Li, BIO | Scotian Shelf | Geology |
| 2005 | 2005-033 Leg 2 | 22 Jul | 29 | R. Smith | D. Mosher, BIO | Labrador Sea Orphan Basin | Geophysics Physics Chemistry |
| 2005 | 2005-040 | 27 Aug | 8 | D. Martin | K. Louden, DAL | Davis Strait | Geophysics |
| 2005 | 2005-045 | 4 Sep | 23 | D. Martin | B. Petrie, BIO | Davis Strait Baffin Bay Labrador Sea | Chemistry |
| 2005 | 2005-048 | 1 Oct | 13 | R. Smith | J. Anderson, NAFC | Scotian Shelf | Biology |
| 2005 | 2005-055 | 17 Oct | 15 | R. Smith D. Martin | E. Head, BIO | Cabot Strait Scotian Shelf Laurentian Channel | Physics Chemistry Biology |
| 2005 | 2005-058 | 5 Nov | 19 | D. Martin | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2005 | 2005-062 | 26 Nov | 18 | P. Bragg | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2006 | 2006-006 | 6 Apr | 7 | P. Bragg | B. Greenan, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2006 | 2006-008 Leg 1 | 19 Apr | 9 | D. Martin | E. Horne, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2006 | 2006-008 Leg 2 | 28 Apr | 3 | D. Martin | E. Horne, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2006 | 2006-008 Leg 3 | 1 May | 6 | D. Martin | E. Horne, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2006 | 2006-011 | 12 May | 11 | P. Bragg | I. Yashayev, BIO | Laurentian Fan Orphan Basin | Physics Chemistry Biology |
| 2006 | 2006-019 | 24 May | 15 | P. Bragg | R. Hendry, BIO | Labrador Sea | Physics Chemistry Biology |
| 2006 | 2006-022 | 14 Jun | 15 | D. Martin | K. Lee, BIO | Scotian Shelf Grand Banks | Chemistry Biology |
| 2006 | 2006-034 | 9 Jul | 14 | P. Bragg | P. Lawton, SABS | Northeast Channel Gulf of Maine | Biology |
| 2006 | 2006-039 | 29 Jul | 6 | T. Gilmore | J. Shaw, BIO | Gully | Geology |
| 2006 | 2006-040 | 5 Aug | 26 | G. Sanders | C. Campbell, BIO | Placentia Bay Orphan Knoll Labrador Sea Hudson Strait Gully | Geology |
| 2006 | 2006-046 | 4 Sep | 8 | T. Gilmore | D. Mosher, BIO | Scotian Slope | Geology |
| 2006 | 2006-048 | 13 Sep | 16 | T. Gilmore | D. Piper, BIO | Grand Banks Laurentian Channel | Geology |
| 2006 | 2006-052 Leg 1 | 5 Oct | 8 | D. Martin | E. Head, BIO | Scotian Slope Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2006 | 2006-052 Leg 2 | 13 Oct | 9 | D. Martin | E. Head, BIO | Scotian Shelf Cabot Strait | Physics Chemistry Biology |
| 2006 | 2006-057 | 27 Oct | 17 | P. Bragg | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2006 | 2006-061 | 14 Nov | 23 | P. Bragg D. Martin | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2006 | 2006-063 | 8 Dec | 4 | D. Martin | N. Cochrane, BIO | Scotian Shelf | Physics Chemistry Biology |

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| 2007 | 2007-001 Leg 1 | 02 Apr | 9 | G. Sanders | E. Home, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2007 | 2007-001 Leg 2 | 11 Apr | 11 | P. Bragg | E. Home, BIO | Scotian Shelf Cabot Strait | Physics Chemistry Biology |
| 2007 | 2007-007 | 29 Apr | 10 | P. Bragg | I. Yashayaev, BIO | Scotian Shelf Laurentian Fan Orphan Basin | Physics |
| 2007 | 2007-011 Leg 1 | 9 May | 18 | T. Gilmore | R. Hendry, BIO | Labrador Sea Scotian Shelf | Physics Chemistry Biology |
| 2007 | 2007-011 Leg 2 | 27 May | 2 | T. Gilmore | R. Hendry, BIO | Scotian Shelf | Physics |
| 2007 | 2007-016 | 7 Jun | 12 | P. Bragg | E. King, BIO | Laurentian Channel Grand Banks | Geology |
| 2007 | 2007-020 | 19 Jun | 15 | P. Bragg | D. Mosher, BIO | Laurentian Fan Grand Banks | Geology |
| 2007 | 2007-025 | 6 Jul | 21 | M. Champagne | E. Kenchington, BIO | Scotian Shelf Grand Banks | Biology |
| 2007 | 2007-033 | 2 Aug | 7 | P. Bragg | B. Greenan, BIO | Scotian Shelf | Physics |
| 2007 | 2007-036 | 12 Aug | 12 | P. Bragg | K. Lee, BIO | Scotian Shelf Grand Banks | Chemistry Biology Physics |
| 2007 | 2007-045 Leg 1 | 28 Sep | 10 | P. Bragg | E. Head, BIO | Scotian Shelf | Chemistry Biology Physics |
| 2007 | 2007-045 Leg 2 | 8 Oct | 11 | P. Bragg | E. Head, BIO | Scotian Shelf Cabot Strait | Physics Chemistry Biology |
| 2007 | 2007-049 | 25 Oct | 20 | M. Champagne | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2007 | 2007-053 Leg 1 | 16 Nov | 5 | M. Champagne | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf | Physics Chemistry Biology |
| 2007 | 2007-053 Leg 2 | 21 Nov | 17 | P. Bragg | E. Colbourne, NAFC | Labrador Shelf Scotian Slope Grand Banks | Physics Chemistry Biology |
| 2008 | 2008-004 Leg 1 | 10 Apr | 7 | A. Croft | E. Home, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2008 | 2008-004 Leg 2 | 17 Apr | 15 | A. Croft | E. Home, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2008 | 2008-006 | 8 May | 11 | F. Francy | I. Yashayaev, BIO | Grand Banks Slope Scotian Shelf Orphan Basin | Physics |
| 2008 | 2008-009 | 20 May | 15 | F. Francy | G. Harrison, BIO | Orphan Knoll Labrador Sea Scotian Shelf | Physics Chemistry Biology |
| 2008 | 2008-015 | 10 Jun | 18 | A. Croft | E. Kenchington, BIO | Scotian Shelf | Biology |
| 2008 | 2008-019 | 3 Jul | 12 | P. Bragg | K. Lee, BIO | Grand Banks Gully | Chemistry Biology |
| 2008 | 2008-023 | 17 Jul | 8 | F. Francy | K. Louden, DAL | Scotian Slope | Geophysics |
| 2008 | 2008-027 | 12 Aug | 15 | A. Croft | D. Mosher, BIO | Labrador Shelf | Geology |
| 2008 | 2008-033 | 28 Aug | 26 | P. Bragg | C. Campbell, BIO | Davis Strait | Geology |
| 2008 | 2008-037 Leg 1 | 28 Sep | 9 | ??? | E. Home, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2008 | 2008-037 Leg 2 | 7 Oct | 6 | ??? | E. Home, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2008 | 2008-037 Leg 3 | 14 Oct | 7 | ??? | E. Home, BIO | Scotian Shelf Cabot Strait | Physics Chemistry Biology |
| 2008 | 2008-045 Leg 1 | 24 Oct | 10 | D. Munn | M. Harvey, IML | Gulf of St. Lawrence | Physics Chemistry Biology |

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| 2008 | 2008-045 Leg 2 | 3 Nov | 14 | D. Munn | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2008 | 2008-047 | 21 Nov | 22 | S. Nunn | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf | Physics Chemistry Biology |
| 2009 | 2009-005 Leg 1 | 9 Apr | 8 | D. Munn | E. Horne, BIO | Labrador Shelf Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2009 | 2009-005 Leg 2 | 17 Apr | 10 | D. Munn | E. Horne, BIO | Scotian Shelf Scotian Slope Cabot Strait Grand Banks Slope | Physics Chemistry Biology |
| 2009 | 2009-011 | 2 May | 15 | ??? | I. Yashayaev, BIO | Gully Laurentian Fan Orphan Basin Orphan Knoll Labrador Sea Scotian Slope | Physics Chemistry Biology |
| 2009 | 2009-015 | 17 May | 15 | ??? | R. Hendry, BIO | Labrador Sea Greenland | Physics Chemistry Biology Geophysics |
| 2009 | 2009-019 | 5 Jun | 33 | D. Martin | S. Dehler, BIO T. Funck, GEUS | Labrador Sea Greenland | Physics Chemistry Biology Geophysics |
| 2009 | 2009-030 | 12 Jul | 14 | ??? | E. Kenchington, BIO | Grand Banks Scotian Shelf | Biology |
| 2009 | 2009-031 Leg 1 | 28 Jul | 7 | ??? | P. Lawton, SABS | Browns Channel, Georges Basin | Biology |
| 2009 | 2009-031 Leg 2 | 5 Aug | 7 | ??? | P. Lawton, SABS | German Bank Jordan Basin Browns Bank Bay of Fundy | Biology |
| 2009 | 2009-039 | 27 Aug | 11 | P. Bragg | B. Todd, BIO | Laurentian Channel | Geology |
| 2009 | 2009-044 | 7 Sep | 15 | W. Naugle | E. King, BIO | Grand Banks | Geology |
| 2009 | 2009-048 Leg 1 | 26 Sep | 8 | D. Martin | E. Horne, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2009 | 2009-048 Leg 2 | 4 Oct | 6 | D. Martin | E. Horne, BIO | Scotian Shelf | Physics Chemistry Biology |
| 2009 | 2009-048 Leg 3 | 10 Oct | 9 | D. Martin | E. Horne, BIO | Scotian Shelf Cabot Strait Grand Banks Grand Banks Slope | Physics Chemistry Biology |
| 2009 | 2009-055 Leg 1 | 22 Oct | 11 | P. Bragg | J. Gagne, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2009 | 2009-055 Leg 2 | 2 Nov | 14 | P. Bragg | A. Gagne, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2009 | 2009-059 | 21 Nov | 19 | ??? | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf | Physics Chemistry Biology |
| 2010 | 2010-006 Leg 1 | 9 Apr | 5 | M. Hemeon | E. Horne, BIO | Labrador Shelf Scotian Shelf Scotia Slope | Physics Chemistry Biology |
| 2010 | 2010-006 Leg 2 | 14 Apr | 12 | M. Hemeon | E. Horne, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2010 | 2010-009 Leg 1 | 1 May | 4 | W. Naugle | I. Yashayaev, BIO | Laurentian Fan | Physics |
| 2010 | 2010-009 Leg 2 | 5 May | 7 | D. Martin | I. Yashayaev, BIO | Orphan Basin Orphan Knoll | Physics |
| 2010 | 2010-014 | 13 May | 17 | D. Martin | G. Harrison, BIO | Labrador Sea Laurentian Fan Scotian Shelf | Physics Chemistry Biology |
| 2010 | 2010-020 | 4 Jun | 14 | W. Naugle | M. Li, BIO | Grand Banks | Geology |
| 2010 | 2010-023 | 18 Jun | 15 | W. Naugle | C. Campbell, BIO | Newfoundland Shelf | Geology |

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| 2010 | 2010-029 | 8 Jul | 20 | D. Martin | E. Kenchington, BIO | Gully MPA Flemish Cap Orphan Knoll Tobin's Point | Biology |
| 2010 | 2010-033 Leg 1 | 29 Jul | 6 | S. Nunn | P. Lawton, SABS | Gulf of Maine Northeast Channel | Biology |
| 2010 | 2010-033 Leg 2 | 4 Aug | 7 | W. Naugle | P. Lawton, SABS | Northeast Channel | Biology |
| 2010 | 2010-040 | 26 Aug | 5 | ??? | G. Sonnichsen, BIO | Labrador Shelf | Geology |
| 2010 | 2010-041 | 31 Aug | 16 | ??? | M. Duschesne, GSC | Hudson Bay Foxe Basin | Geology |
| 2010 | 2010-046 | 16 Sep | 5 | ??? | P. Lajeunesse, LVL | Hudson Bay Hudson Strait | Geology |
| 2010 | 2010-055 | 6 Nov | 15 | D. Martin | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry |
| 2010 | 2010-057 | 23 Nov | 18 | W. Naugle | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf | Biology Physics Chemistry Biology |
| 2010 | 2010-049 | 15 Dec | 7 | D. Martin | E. Horne, BIO | Labrador Shelf Scotian Shelf | Physics Chemistry Biology |
| 2011 | 2011-004 Leg 1 | 7 Apr | 6 | D. Martin | E. Horne, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2011 | 2011-004 Leg 2 | 13 Apr | 10 | D. Martin | E. Horne, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2011 | 2011-009 | 6 May | 23 | P. Bragg | I. Yashayaev, BIO | Grand Banks Slope Scotian Shelf Scotian Slope Laurentian Fan Labrador Sea | Physics Chemistry Biology |
| 2011 | 2011-014 | 4 Jun | 10 | D. Martin | E. Kenchington, BIO | Scotian Shelf Laurentian Chanel | Biology |
| 2011 | 2011-017 | 15 Jun | 12 | D. Martin | L. Burrige, SABS | Scotian Shelf Grand Banks | Chemistry Biology |
| 2011 | 2011-031 | 31 Jul | 23 | D. Martin | C. Campbell, BIO | Flemish Pass Grand Banks | Geology |
| 2011 | 2011-036 | 30 Aug | 17 | P. Bragg | B. Todd, BIO | Bay of Fundy | Geology |
| 2011 | 2011-043 Leg 1 | 23 Sep | 8 | D. Martin | E. Head, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2011 | 2011-043 Leg 2 | 1 Oct | 15 | D. Martin | E. Head, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2011 | 2011-050 Leg 1 | 21 Oct | 10 | K. Brown | P. Joly, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2011 | 2011-050 Leg 2 | 1 Nov | 14 | K. Brown | A. Gagné, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2011 | 2011-051 | 20 Nov | 20 | W. Naugle | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf | Physics Chemistry Biology |
| 2012 | 2012-042 Leg 1 | 24 Sep | 9 | K. Brown | E. Horne, BIO | Labrador Shelf Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2012 | 2012-042 Leg 2 | 3 Oct | 5 | K. Brown | E. Horne, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2012 | 2012-042 Leg 3 | 8 Oct | 8 | K. Brown | E. Horne, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2012 | 2012-045 Leg 1 | ??? | 9 | D. Martin | P. Joly, IML | Gulf of St. Lawrence | Physics Chemistry Biology |

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| 2012 | 2012-045 Leg 2 | 29 Oct | 15 | D. Martin | F. Villeneuve, IML | Gulf of St. Lawrence St. Lawrence Estuary | Biology Physics Chemistry |
| 2012 | 2012-046 | 19 Nov | 20 | ??? | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Biology Physics Chemistry Biology |
| 2013 | 2013-004 Leg 1 | 4 Apr | 8 | D. Martin | D. Hebert, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2013 | 2013-004 Leg 2 | 13 Apr | 13 | D. Martin | D. Hebert, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2013 | 2013-008 | 4 May | 24 | ??? | I. Yashayaev, BIO | Northwest Atlantic Scotian Shelf Labrador Sea | Physics Chemistry Biology |
| 2013 | 2013-013 | 4 Jun | 12 | R. Cotie | E. Home, CESD B. Law, CESD | Bay of Fundy Minas Basin | Physics Chemistry Biology |
| 2013 | 2013-021 | 28 Jun | 11 | R. Cotie | B. Greenan, BIO | Flemish Pass Flemish Cap Sackville Spur Grand Banks | Physics Biology |
| 2013 | 2013-023 | 10 Jul | 9 | R. Cotie | S. Courtney, BIO | Grand Banks | Chemistry Biology |
| 2013 | 2013-029 Leg 1 | 14 Aug | 7 | ??? | C. Campbell, BIO | Hatton Basin Baffin Bay | Geology |
| 2013 | 2013-029 Leg 2 | 21 Aug | 27 | ??? | C. Campbell, BIO | Baffin Bay | Geology Biology |
| 2013 | 2013-037 Leg 1 | 21 Sep | 9 | D. Martin | A. Cogswell, BIO | Scotian Shelf Scotian Slope Cabot Strait | Physics Chemistry Biology |
| 2013 | 2013-037 Leg 2 | 30 Sept | 10 | D. Martin | A. Cogswell, BIO | Scotian Shelf Scotian Slope Cabot Strait Gulf of Maine | Physics Chemistry Biology |
| 2013 | 2013-038 Leg 1 | 17 Oct | 12 | R. Cotie | P. Joly, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2013 | 2013-038 Leg 2 | 28 Oct | 16 | R. Cotie | F. Villeneuve, IML | Gulf of St. Lawrence | Physics Chemistry Biology |
| 2013 | 2013-040 | 12 Nov | 5 | ??? | H. Moors-Murphy, BIO | Scotian Shelf | Biology |
| 2013 | 2013-042 | 16 Nov | 22 | ??? | E. Colburne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2014 | 2014-004 Leg 1 | 4 Apr | 4 | R. Cotie | A. Cogswell, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2014 | 2014-004 Leg 2 | 9 Apr | 14 | R. Cotie | A. Cogswell, BIO | Scotian Shelf Scotian Slope Cabot Strait Laurentian Channel Northeast Channel | Physics Chemistry Biology |
| 2014 | 2014-007 | 2 May | 22 | ??? | I. Yashayaev, BIO | Scotian Shelf Northwest Atlantic Labrador Sea | Physics Chemistry Biology |
| 2014 | 2014-035 | 31 May | 21 | D. McEwan | Y. Gagnon, IML | Gulf of St Lawrence | Physics Chemistry Biology |
| 2014 | 2014-017 | 30 Jun | 15 | D. Martin | B. Greenan, BIO | Labrador Sea Flemish Cap Scotian Slope | Physics |
| 2014 | 2014-030 Leg 1 | 19 Sep | 9 | R. Cotie | D. Hebert, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2014 | 2014-030 | 28 Sept | 10 | R. Cotie | D. Hebert, BIO | Scotian Shelf | Physics |

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| | | Leg 2 | | | | Scotian Slope Cabot Strait Northeast Channel Gulf of St Lawrence | Chemistry Biology |
| 2014 | 2014-033 Leg 1 | 18 Oct | 9 | D. Martin | P. Joli, IML | | Physics Chemistry Biology |
| 2014 | 2014-033 Leg 2 | 27 Oct | 16 | D. Martin | F. Villeneuve, IML | Gulf of St Lawrence St. Lawrence Estuary | Physics Chemistry Biology |
| 2014 | 2014-034 | 16 Nov | 21 | D. McEwan | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2015 | 2015-004 | 17 Apr | 10 | D. London | A. Cogswell, BIO | Scotian Shelf Scotian Slope Northeast Channel | Physics Chemistry Biology |
| 2015 | 2015-006 | 1 May | 26 | ??? | I. Yashayaev, BIO | Scotian Shelf Scotian Slope Labrador Sea | Physics Chemistry Biology |
| 2015 | 2015-011 | 2 Jun | 16 | ??? | E. Kenchington, BIO | Laurentian Channel Scotian Shelf Laurentian Channel Grand Banks | Biology |
| 2015 | 2015-018 | 25 Jun | 14 | C. Lacombe | C. Campbell, BIO | Scotian Slope | Geology |
| 2015 | 2015-030 Leg 1 | 20 Sep | 5 | P. Bragg | D. Hebert, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2015 | 2015-030 Leg 2 | 25 Sept | 8 | P. Bragg | D. Hebert, BIO | Scotian Shelf Cabot Strait Channel Northeast Channel Gulf of Maine | Physics Chemistry Biology |
| 2015 | 2015-033 | 18 Oct | 19 | D. Martin | C. Lafleur, IML | Gulf of St. Lawrence St. Lawrence Estuary | Physics Chemistry Biology |
| 2015 | 2015-035 | 14 Nov | 22 | J. Strickland | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2016 | 2016-003 Leg 1 | 9 Apr | 3 | R. Cotie | D. Hebert, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2016 | 2016-003 Leg 2 | 15 | 10 | R. Cotie | D. Hebert, BIO | Scotian Shelf Scotian Slope Northeast Channel | Physics Chemistry Biology |
| 2016 | 2016-006 | 30 Apr | 26 | ??? | I. Yashayaev, BIO | Cabot Strait Labrador Sea Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2016 | 2016-011 Leg 1 | 2 Jun | 12 | R. Cotie | C. Campbell, BIO | Scotian Slope | Geology |
| 2016 | 2016-011 Leg 2 | 15 Jun | 21 | J. Strickland | C. Campbell, BIO | Scotian Slope | Geology |
| 2016 | 2016-019 | 14 Jul | 32 | R. Cotie | E. Kenchington, BIO | Scotian Shelf Kelvin Seamount Bermuda Bank Bowditch Seamount | Physics Chemistry Biology |
| 2016 | 2016-027 Leg 1 | 15 Sep | 10 | R. Cotie | A. Cogswell, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2016 | 2016-027 Leg 2 | 25 Sept | 11 | R. Cotie | A. Cogswell, BIO | Scotian Shelf Scotian Slope Cabot Strait Northeast Channel Gulf of Maine | Physics Chemistry Biology |
| 2016 | 2016-031 Leg 1 | 15 Oct | 7 | D. Martin | M. Scarratt, IML | St. Lawrence Estuary | Physics Chemistry Biology |
| 2016 | 2016-031 Leg 2 | 22 Oct | 13 | D. Martin | F. Villeneuve, IML | Gulf of St. Lawrence St. Lawrence Estuary | Physics Chemistry |

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| 2016 | 2016-034 | 12 Nov | 22 | C. Lacombe | E. Colbourne, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Biology Physics Chemistry Biology |
| 2017 | None | | | | | | |
| 2018 | 2018-004 | 6 Apr | 18 | R. Cotie | A. Cogswell, BIO | Scotian Shelf Scotian Slope Cabot Strait Laurentian Channel Northeast Channel Gulf of Maine | Physics Chemistry Biology |
| 2018 | 2018-008 | 26 Apr | 27 | F. Francey | I. Yashayaev, BIO | Scotian Shelf Cabot Strait Labrador Sea | Physics Chemistry Biology |
| 2018 | 2018-041 | 26 May | 20 | R. Cotie | C. Campbell, BIO | Scotian Slope | Geology |
| 2018 | 2018-021 | 21 Jun | 14 | F. Francey | L. Beazley, BIO | Scotian Shelf Scotian Slope | Biology |
| 2018 | 2018-027 | 6 Jul | 11 | F. Francey | P. Lawton, SABS | Laurentian Channel | Biology |
| 2018 | 2018-042 | 17 Aug | 25 | F. Francey | A. Normandeau, BIO | Southern Baffin Bay | Geology |
| 2018 | 2018-030 | 15 Sep | 20 | R. Cotie | D. Hebert, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2018 | 2018-038 Leg 1 | 11 Oct | 12 | F. Francey | G. Perrin, IML | Gulf of St. Lawrence | Biology |
| 2018 | 2018-038 Leg 2 | 22 Oct | 13 | F. Francey | D. LeBlanc, IML | Gulf of St. Lawrence St. Lawrence Estuary | Physics Chemistry Biology |
| 2018 | 2018-035 | 10 Nov | 23 | D. Martin | S. Snook, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2019 | None | | | | | | |
| 2020 | 2020-066 | 30 Aug | 8 | F. Francey | H. Moors-Murphy, BIO | Scotian Shelf Scotian Slope Gulf of Maine Georges Bank Cabot Strait | Physics Biology |
| 2020 | 2020-063 Leg 1 | 3 Oct | 4 | R. Lockyer | L. Beazley, BIO | Scotian Shelf Scotian Slope Northeast Channel | Physics Chemistry Biology |
| 2020 | 2020-063 Leg 2 | 8 Oct | 7 | F. Francey | L. Beazley, BIO | Scotian Shelf Scotian Slope Laurentian Channel Cabot Strait | Physics Chemistry Biology |
| 2020 | 2020-069 | 18 Oct | 13 | F. Francey | S. Michaud, IML | Gulf of St. Lawrence St. Lawrence Estuary | Physics Chemistry Biology |
| 2020 | 2020-071 | 7 Nov | 22 | R. Strowbridge | S. Snook, NAFC | Grand Banks St. Pierre Bank Flemish Cap Newfoundland Shelf Labrador Shelf | Physics Chemistry Biology |
| 2021 | 2021-126 | 21 July | 6 | F. Francey | E. King, BIO | Scotian Shelf Scotian Slope | Geology |
| 2021 | 2021-019 | 29 July | 17 | F. Francey | A. Ortmann, BIO | Scotian Shelf Newfoundland Shelf | Chemistry Biology |
| 2021 | 2021-110 | 17 Aug | 21 | D. London | H. Moors-Murphy, BIO | Scotian Shelf and Slope Gulf of Maine Georges Bank | Biology |
| 2021 | 2021-048 | 9 Sept | 4 | F. Francey | E. Kenchington, BIO | Scotian Shelf | Biology |
| 2021 | 2021-185 | 16 Sept | 18 | F. Francey | C. Layton, BIO | Scotian Shelf Scotian Slope | Physics Chemistry Biology |
| 2021 | 2021-077 | 10 Oct | 18 | D. London | D. Leblanc, IML | Gulf of St. Lawrence St. Lawrence Estuary | Physics Chemistry Biology |