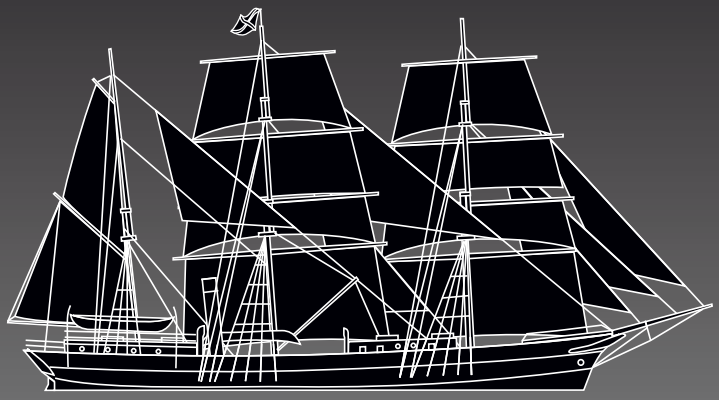
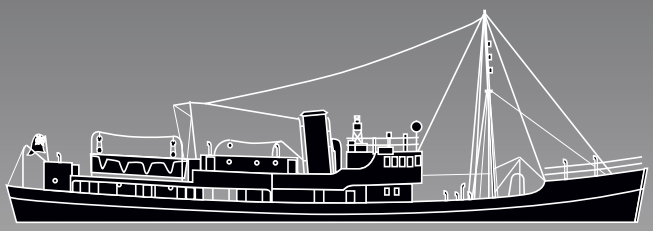
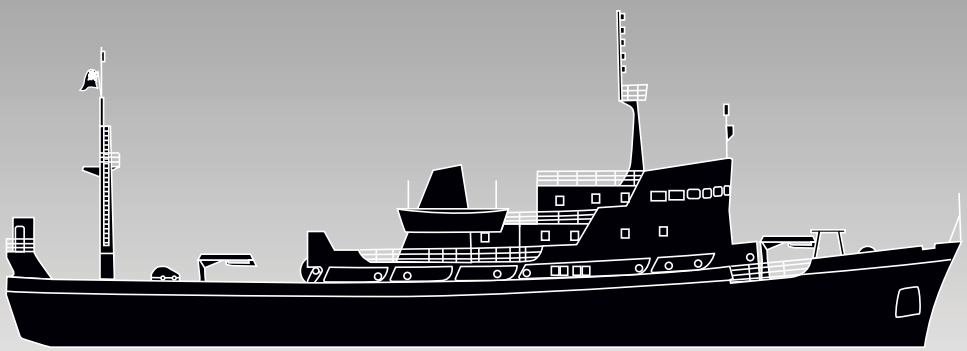
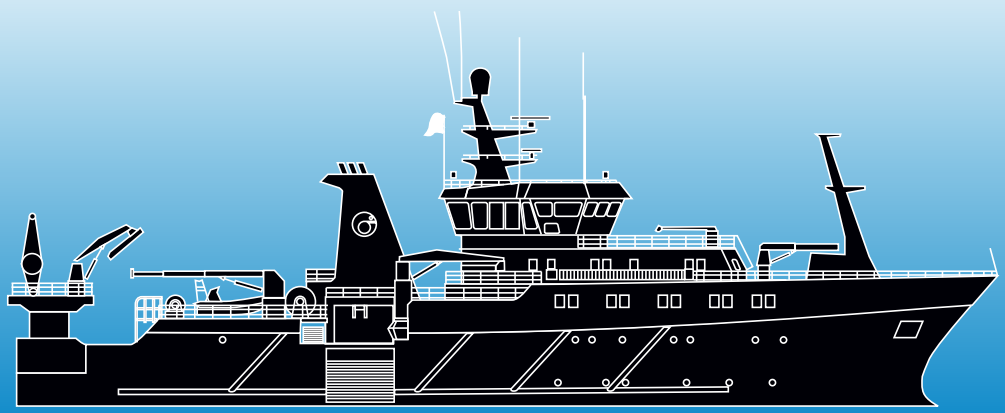






SCOTIA

The Four Research Ships



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SCOTIA

The Four Research Ships

by A. D. Hawkins

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Preface

1998 has witnessed the completion in Port Glasgow of a new oceanographic research ship, commissioned by The Scottish Office. She is the fourth research vessel to be given the proud name, *Scotia*. Spanning the whole of this century, each of *Scotia*'s three predecessors has had a distinguished history of exploration and scientific achievement in the cold inhospitable seas of the Antarctic and the North Atlantic. This account records some of that proud past and looks forward to the next century with a new state-of-the-art *Scotia*.

Scotia's winter quarters, Laurie Island, 1903

The steam yacht *Scotia*

The first *Scotia* was a wooden sailing ship which took part in the Scottish National Antarctic Expedition of 1902–1904, to the Southern Ocean. The venture was funded by public subscription with much of the money coming from the Coats family of Paisley, manufacturers of sewing threads. From the start it was controversial. The end of the 19th century was a time when many expeditions to the Antarctic were being planned. The Scottish expedition was conceived and led by William Speirs Bruce, an experienced polar explorer and fervent Scottish nationalist. The voyage was a distinctly Scottish venture which was opposed by Sir Clements Markham, President of the Royal Geographical Society. He referred to 'mischievous rivalry' between the Scottish expedition and the much better funded and publicised *Discovery* expedition led by Robert Falcon Scott, which left for the Antarctic one year earlier. The purpose of the Scottish expedition, however, was not to race for the Pole, or to compete with others, but to carry out systematic oceanographic and meteorological observations in the Antarctic Ocean, and to do so in the name of Scotland. In Bruce's own words ' "Science" was the talisman of the Expedition, "Scotland" was emblazoned on its flag.'

The *Scotia* was a strikingly beautiful Norwegian whaler, formerly known as *Hekla*. Purchased on the advice of Colin Archer, the builder of Fridtjof Nansen's *Fram* which had earlier drifted across the Arctic Ocean locked into the ice, *Hekla* had sailed on a Danish expedition to the coast of Greenland in 1891–1892. She was in poor condition when she arrived in Scotland and was almost entirely rebuilt by the Ailsa Shipbuilding Company of Troon under the direction of G L Watson, who gave his services entirely free. A barque-rigged auxiliary screw steamer of 400 tons and 140 feet long, she was built of wood throughout and sheathed in greenheart to protect her from the damaging effects of pack ice. She was equipped with a laboratory, good accommodation for the scientists and crew, and the latest engines and winches for dredging and trawling.

Voyage of the Scotia, 1902–1904

Captained by Thomas Robertson, an experienced ice navigator from Peterhead, *Scotia* left Troon in November 1902. The ship reached the Falkland Islands in January 1903 and then pressed south across what is now known as the Scotia Sea, aiming to reach the unexplored waters of the Weddell Sea before the southern winter set in. After passing the South Orkney Islands, *Scotia* encountered tightly packed ice at 70° 25´S and, to avoid wintering in open pack ice, where scientific work would be very limited, the ship retreated north early in March to winter in the South Orkneys. She anchored in a large bay off Laurie Island, later named Scotia Bay, just before ice jammed the entrance. Within days of arrival, *Scotia* was locked in, and remained so until November.

The South Orkney Islands were almost unknown to scientists until the visit of *Scotia*. However, they formed an ideal spot in which to spend the winter and make meteorological observations. The islands are situated on the edge of the ice-bound sea, far to the south of Cape Horn and its storms. *Scotia* was able to stay with safety within the polar ice, yet in an area rich in seals, birds and marine life. Throughout the winter in the South Orkneys the expedition members made a series of scientific observations from *Scotia*, built a sturdy house on land and established small meteorological and magnetic observatories. While water remained open, and even through the ice, the scientists took a series of dredge and trawl samples, revealing a rich marine fauna within the bay.

With her release from the ice in November, *Scotia* sailed north to the Falkland Islands and then to Buenos Aires for re-provisioning. She left behind a small party in the South Orkneys who continued to make meteorological observations through-out her absence. *Scotia* eventually returned in February 1904, rather later than expected and to the great relief of those left on the islands, bringing with her three Argentinian replacements for the Scottish shore party. Together with Robert Mossman, the expedition's meteorologist, the Argentinian party remained in the South Orkneys for a further winter, the station being ceded to the Government of Argentina with the approval of the British Foreign Office and the Admiralty.

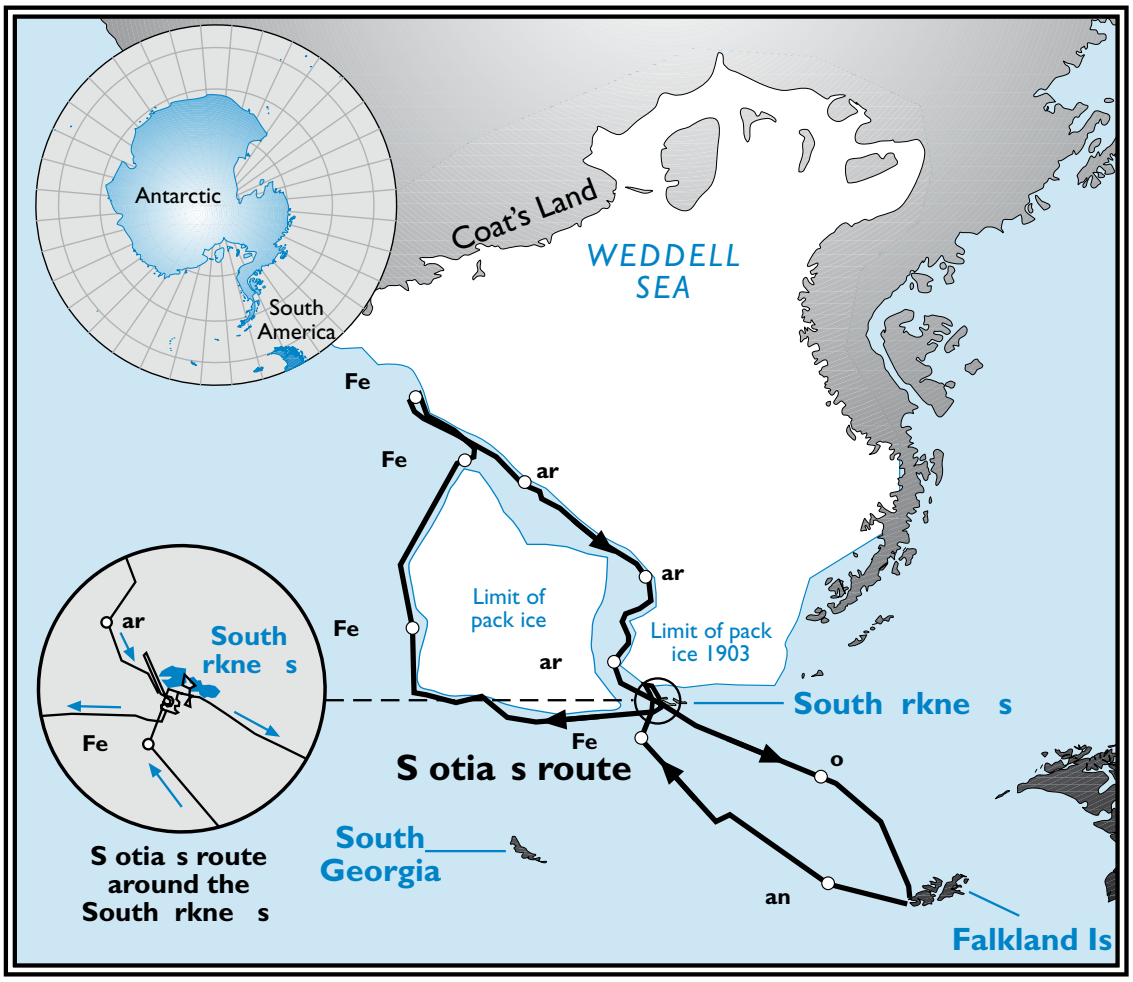
Scotia left Laurie Island south bound on 22 February 1904, carrying the first mail ever to leave Antarctica, with franked Argentinian postage stamps (to which Falkland Islands or Cape of Good Hope stamps were later added). She sailed farther south across difficult and dangerous waters to encounter a new ice-bound part of the Antarctic continent, named 'Coats Land' by Bruce after the expedition's sponsors. New depth soundings were made in the Weddell Sea, allowing the eastern part of this poorly explored sea to be delineated for the first time. For a while *Scotia* became trapped for a while in pack ice

The steam yacht Scotia

at 74° 01' S, and wintering within the ice became a distinct possibility. However, the weather improved, enabling *Scotia* to break free and sail north, where Bruce was able to explore further the bathymetry and marine biology of the Weddell Sea. The suspected 'Ross Deep' was shown to be an error in the soundings taken in 1843 by Captain James Clark Ross in command of HMS *Erebus* and HMS *Terror*. Then, having completed a full programme of scientific observations, *Scotia* moved out of the Weddell Sea in early April and made for Gough Island, some 200 miles due south of Tristan da Cunha; her route took her to Cape Town, St Helena, Ascension Island and the Azores, finally anchoring in the Clyde off Millport in July 1904.

The voyage of *Scotia* lasted 20 months and covered over 23,600 miles [37,000 km]. It was one of the last Antarctic expeditions in a wooden ship, without the benefit of radio communication, or acoustic sounding equipment. And there was no provision for a relief ship should the *Scotia* come to grief. 'We'll have to get out ourselves or stay there for good' was Bruce's philosophy. However, the voyage was one of extraordinary achievement. The meteorological station established in the South Orkneys was renamed Orcadas and is still there today, operated by the government of Argentina. It is the oldest scientific base with continuous records in the whole of Antarctica, and plays an important role in monitoring weather conditions far to the south of Cape Horn.

The success of the expedition owed much to the character of Bruce himself. He was a friend of two of the greatest polar explorers, Nansen and Amundsen, and had previously visited the Antarctic



Route taken by *Scotia* during the first year (1903) of the Scottish National Expedition, 1902–1904

as naturalist on board the whaler *Balaena*. He had carried out earlier work in the Arctic, much of it in the company of Prince Albert of Monaco, founder of the world's first major oceanographic laboratory. He realised that new work in the uncharted Southern Ocean required the application of new techniques and new equipment, and he had ensured that *Scotia* carried a greater range of oceanographic equipment than any previous Antarctic ship.

Oceanographic developments

By the late 19th century exploration of the seas had entered a new phase—it was no longer confined to surface waters, with occasional sounding and dredging in deeper water. Skilled designers had invented new instruments for oceanographic work. Measurement of temperature at depth had involved collecting water in an insulated container and bringing it to the surface for measurements to be made but, by the turn of the century, a range of thermo-meters had been developed which registered the temperature directly at depth. The reversing thermometer, which tipped through 180° when it reached the appropriate depth to register the temperature, was very effective and had been patented by Negretti and Zambra in 1874, and later modified by Knudsen. Water samples, for analysis of salinity and water chemistry, had been collected in a great variety of ways: bottles could be closed at depth, either triggered by contact with the seabed, or by the act of hauling the bottle upwards, or by a messenger weight, slid down the line from the ship. John Buchnanan, the chemist on the *Challenger* expedition, had designed a tubular bottle with two stopcocks at each end of the tubular bottle which were closed by hauling and releasing the line before fast hauling to the surface began. This system was then modified by Buchanan, with the help of Captain Richard, commander of Prince Albert's yacht *Hirondelle*, to operate with a messenger weight. Depth soundings, made by paying out a line with a weight attached, had been particularly awkward in earlier times because it was difficult to obtain light strong line and to detect the precise length at which the sounding weight made contact with the seabed. However, the laying of telegraph wires across the seas, which began earlier in the century had greatly helped the development of accurate sounding techniques. A sounding machine on *Scotia* had been developed by Francis Lucas, who had served on *Great Eastern* in the first attempt to lay a transatlantic cable in 1856. His machine payed out wire and applied a friction brake when the sounding weight reached the seabed. The *Scotia* machine carried 6,000 fathoms [10,973 m] of specially-made, treble-strand wire. The wire terminated in a Buchanan sounding tube, and immediately above it was clamped a Buchanan–Richard water bottle and a Knudsen modification of the Negretti and Zambra reversing thermometer.

New fishing nets and other contrivances for securing samples of marine life had also been devised. *Scotia* took plankton hauls at the surface, or at depth, using closing nets. The deep-sea trawl was designed in Monaco and constructed so that it was immaterial which side was in contact with the seabed. It was attached to the ship by a single steel cable, let out at a rate of 1,000 fathoms an hour [1,829 m/hr]. It was hauled by a steam winch, but the cable was stored on a drum which had to be wound by six men, three at each handle—an exhausting activity.

Scotia's scientific achievements

Some 150 trawl hauls were taken by *Scotia* at depths down to 293 m, and 48 deeper hauls were obtained at 1,830 to 4,575 m, resulting in a collection of Ant-

The steam yacht *Scotia*

arctic marine invertebrates which for many years was unmatched by any other expedition. Seabed deposits were extensively charted, and pioneering reports produced on Antarctic birds and mammals. The *Scotia* expedition achieved all its objectives and added substantially to knowledge of the outline of the Antarctic continent, and to the bathymetry of the Weddell and Scotia Seas. Many of the specimens collected by *Scotia* are now retained by the National Museums of Scotland in Edinburgh, and include species of Antarctic fish which were then new to science.

Back home, Bruce was not forgiven by Sir Clements Markham for mounting a separate Scottish expedition and he never received the rewards due to him. The coveted Polar Medal of the Royal Geographical Society was not awarded to the crew of *Scotia*, as it had been for earlier expeditions. Bruce instead designed his own medal, which was presented to the scientists and a number of the crew.

In selecting his scientific companions, Bruce had looked for specific skills, youth and enthusiasm. In choosing his crew he had sought out those with experience in polar waters. There were no brass-bound officers strictly adhering to naval etiquette and routine. The majority of the sailors were experienced Arctic whalers, many of them from Dundee. He paid particular attention to the welfare of the scientists and sailors involved in the expedition and wrote, 'I would like them to regard the ship as their university, as their alma mater in the highest possible sense. Not an institution given in any way to getting through examinations, but as one in which they will be able to study the various phenomena of Nature, without bias from Nature itself.' Bruce's memory is honoured to this day: the Bruce Memorial Prize is awarded by the Royal Society of Edinburgh to scientists at the outset of their careers for their notable contribution to research in polar regions.

Scotia's final years

After the expedition, Bruce hoped that *Scotia* would continue to be engaged in oceanographic work and especially in the training students from Scottish universities, but this was not to be. The ship was sold in 1905 to a Dundee whaling syndicate and subsequently sailed for several years to the Greenland whaling fishery. Following the tragic loss of *Titanic* in 1912, *Scotia*, fitted with an early wireless, was used on the Atlantic Ice Patrol, again under the command of Thomas Robertson and during this period returned briefly to scientific work. Extensive meteorological, hydrographic and biological observations were carried out in the iceberg area of the North Atlantic.

Early in the First World War *Scotia* was sold once more and had a short career as a cargo vessel before she finally caught fire and was run ashore in 1916 at Sully, Glamorgan, as a wreck. This was an undignified end for so fine a ship, which had carried scientific expeditions to both ends of the earth. But the name of the first *Scotia* is commemorated on the bows of the ships which have succeeded her.

Steam trawler *Scotia* leaving Aberdeen Harbour

The steam trawler *Scotia*

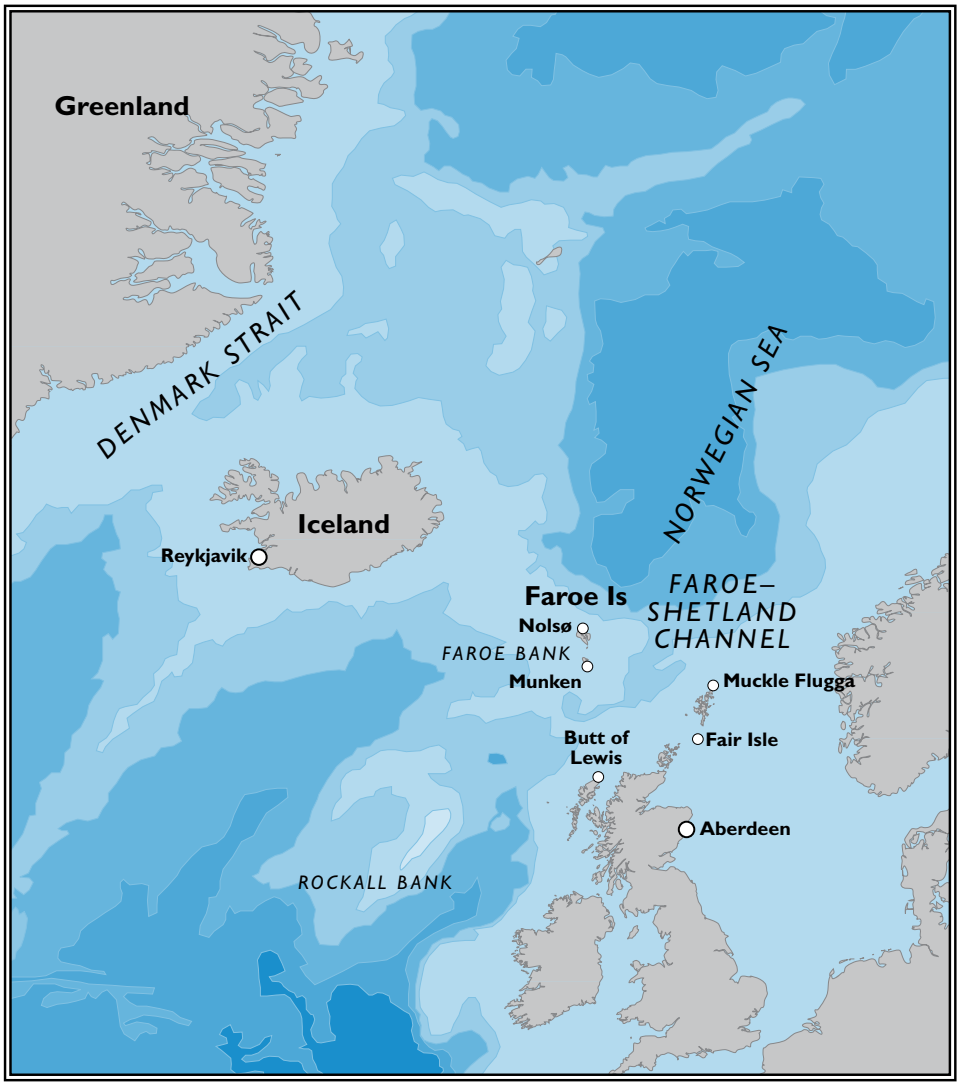
The next *Scotia* was a 150 foot ex-Admiralty Shakespearian class trawler, launched in 1940 by Cochrane and Sons Ltd of Selby. Originally named *Fluellen*, she was a coal burner (later converted to oil), powered by a three-cylinder, triple expansion, steam engine. The vessel served initially as a minesweeper off the south coast of England and then in the Mediterran-ean. The Scottish Home Department acquired her in 1948, as a 'hydrographic -plankton research vessel' and renamed her *Scotia*. Remarkably, the first commander of the ship was Captain Eillium Alastair Bruce, the son of William Bruce, leader of the Scottish National Antarctic Expedition.

The narrow, naval lines of the ship, together with her high superstructure (which was later reduced), made her lively in rough weather, and she was prone to drift in high winds, making trawling and plankton hauls difficult to perform. Even when dodging in bad weather her movements were quite violent, and heavy following seas were feared. The crew believed that at least one of her sister ships had turned turtle in a storm. *Scotia* was not a comfortable ship to sail on. However, despite this and her limited fuel capacity and restricted cruising range, she sailed throughout the North Atlantic on Marine Laboratory business conducting, with an older, pre-war ship *Explorer*, a

wide-ranging programme of hydrographic research which had been interrupted by the war.

Scotia's survey work in the North Atlantic

Scotland is located at one end of a submarine ridge running through the Faroe Islands and Iceland to Greenland. The ridge separates the deep waters of the Norwegian Sea from those of the Atlantic, and across it water is exchanged between these two major basins, influencing the climate and productivity of the whole North Atlantic. Surveys along the ridge for the Fishery Board for Scotland had first begun in 1893, when H N Dickson had measured the temperature and salinity of the very variable quantities of Atlantic and Arctic water flowing through the Faroe–Shetland Channel. These surveys were later resumed after the First World War and then again after the Second World War when *Scotia* continued and expanded an earlier programme of plankton and hydrographic surveys across the ridge along a series of lines: from the Butt of Lewis to Faroe Bank, from Fair Isle to Munken in Faroe, and from Nolsø to Muckle Flugga. Today these survey results form one of the longest time series of hydrographic observations in the world, and have been invaluable in pointing to long term oceano-graphic and climate changes in the North Atlantic.



Map showing area of the North Atlantic in which *Scotia* operated

From *Scotia* the Marine Laboratory also carried out pioneering studies of the drifting plants and animals (including fish larvae) that populate the seas around Scotland. Results revealed that water masses of different origin are populated by 'indicator' organisms, which can be used to follow the movements of these water masses of differing fertility, temperature and salinity as they move around Scotland from the North Atlantic and into the North Sea.

On her long cruises to the north of Scotland, *Scotia* often refuelled in Klaksvig in the Faroes or Reykjavik in Iceland. In August 1949, while in Thorshavn, in the Faroes, the scientists on board reported one of the great slaughters of pilot whales which then took place in the islands. They described how 81 whales were killed in the inner harbour, the water turning red with blood. Great excitement prevailed during the hunt, with all the shops closed and all work stopping, including the coaling of the ship.

Scotia later began a series of cruises to Denmark Strait between Iceland and East Greenland. The waters beyond Iceland are dangerous. On one research cruise in 1954, when *Scotia* was line fishing for halibut east of Greenland, a violent storm hit the area and the ship endured mountainous seas. A continuous watch had to be kept for ice, which bore down on the ship from different directions as the wind changed direction. Bruce was an experienced seaman and navigator, however. Under his command, *Scotia* also sailed regularly to Rockall Bank and the west of Ireland, as well as across the northern North Sea. From 1957 to 1958 the ship took part in the North Atlantic Polar Front Survey, an integral part of the worldwide programme of the International Geophysical Year, sponsored by the International Council for Exploration of the Sea (ICES) and the International Commission for the Northwest Atlantic Fisheries (ICNAF). Twenty ships from ten countries investigated the hydrographic conditions in the North Atlantic from Spitsbergen to the Azores.

Development of oceanographic instruments

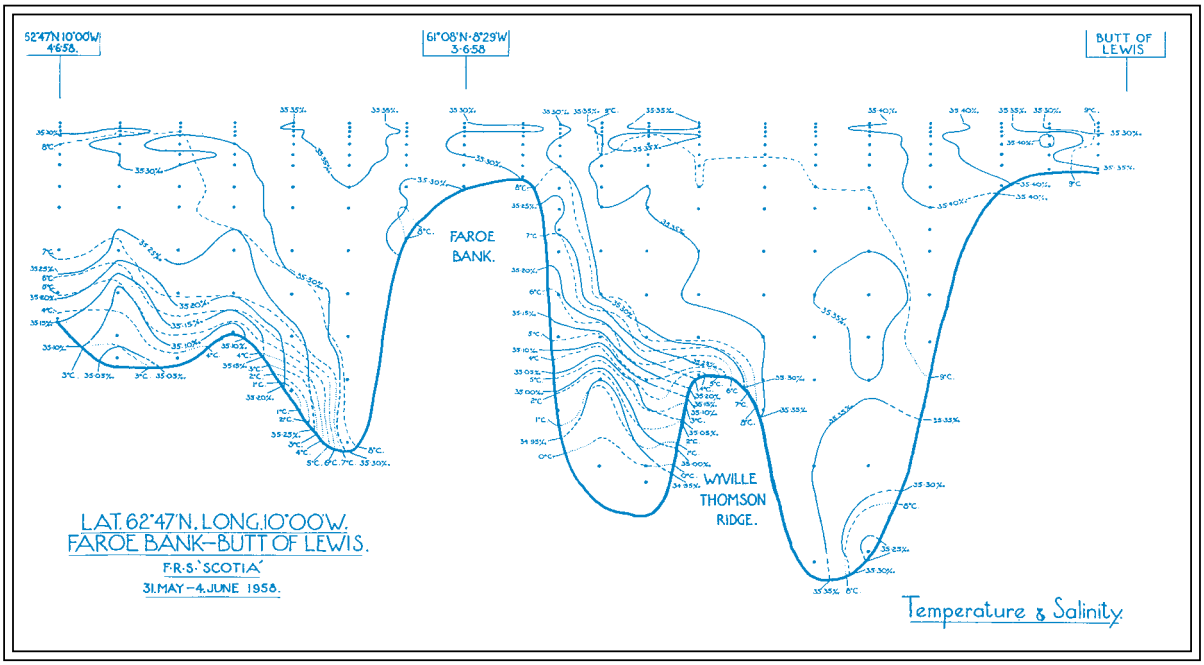
At the beginning of the steamship *Scotia*'s life William Bruce could have recognised much of her oceanographic equipment, although developments had resulted in greater reliability and precision. The founding of ICES in 1902 and the establishment of an international programme of fisheries work gave great impetus to the further development of oceanographic instruments. Scientists working with the ICES Central Laboratory at Kristiania (now Oslo) under the direction of Fridtjof Nansen had improved the design of water bottles and reversing thermometers considerably. Typically, on a cruise of the Faroe–Shetland Channel, *Scotia* would monitor temperature, salinity, oxygen and nutrient levels at a range of depths, using water samplers and thermometers tethered to a weighted wire. Samples of plankton would be obtained using vertically towed Hensen and Standard nets, and by towing silk nets horizontally and obliquely. Scientists monitored surface water currents by casting overboard sealed drift bottles, to be picked up days, months and even years later.

Although never as capable at trawling as her contemporaries—the pre-war Mersey Class trawler *Explorer*, or the later research ship of the same name— *Scotia* deployed a wide range of fishing methods, including a 30 foot demersal trawl, great lines and early pelagic trawls.

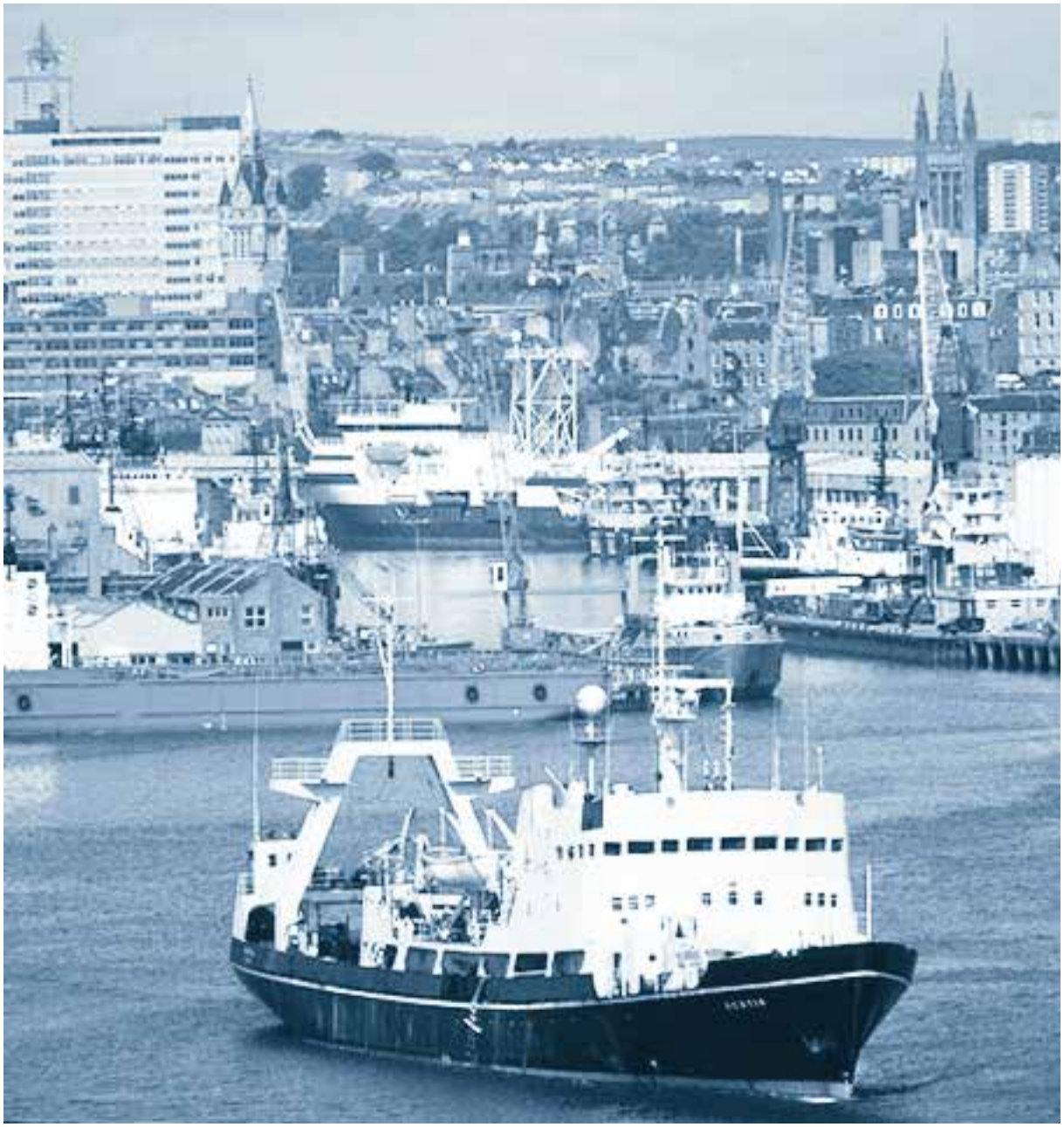
Completely new measuring devices were also used, however, which would have gone unrecognised by William Bruce and the earlier oceanographers. In particular,

depth was now obtained using the echo-meter or echosounder, rather than by earlier sounding wires. In the 1920s simple devices had been constructed to make a sharp sound, with an electric hammer, and then measure the time taken for sound to travel to the seabed and back, thus registering the depth. By the time of the Second World War, efficient high frequency electronic echo-sounders were available, capable of registering the depth of the seabed beneath the ship on a continuous paper record. By the 1950s, *Scotia* was able not only to measure depth with the echosounder, but also to register the depth and shape of herring shoals beneath the ship, and to investigate the vertical movements of sound scattering layers of planktonic organisms. New high speed plankton nets had been developed too, allowing samples to be taken while the ship was underway. Underwater cameras, including the new underwater television camera, were de-ployed, and new radio navigational aids like Loran and Decca were introduced enabling the position of the ship to be determined with much greater precision. Currents were tracked with large parachute drogues, larger equivalents of the earlier drift bottles, placed at a particular depth and marked by a small surface buoy which could be followed by the ship. Later still, electronic current meters were placed at particular locations, moored to the seabed. A new generation of fishery scientists learned their trade on *Scotia* and pioneered many of the sampling methods we now take for granted.

Scotia served the Marine Laboratory until 1971, operating under the name *Scarba* for the latter part of that year. Her last cruise as a research vessel ended on 12 November 1971, when she transferred to fishery protection duties. *Scarba* was later withdrawn from service in May 1973 and then broken up in November of the same year.



Temperature and salinity records taken from *Scotia,* May–June 1958



Diesel-electric trawler *Scotia* leaving Aberdeen Harbour

The diesel-electric trawler *Scotia*

The third *Scotia* — a purpose-built, diesel-electric trawler, 224 feet long — was launched in March 1971 from the yard of Ferguson Brothers, Port Glasgow, and commissioned in November that year.

Scotia carried out her first trawling trials for the Marine Laboratory in March 1972. She was one of three similar ships; the other two were *Cirolana*, operated by the Lowestoft Laboratory, and *Africana*, built

in Durban in 1981 for the South African Fisheries Ministry.

Scotia's early cruises

One of *Scotia*'s first cruises in 1972 was to West Greenland to investigate the new and growing sea fishery for Atlantic salmon. In the 1960s scientists from the Freshwater Fisheries Laboratory had shown from tagging experiments (in Scottish rivers) that salmon originating in Scotland migrated within the ocean as far as the Faroe Islands and Greenland before returning 'home' to spawn. The rise of a large-scale fishery at West Greenland had therefore caused concern for the survival of the fish. Now, as a result of the pioneering work done at Greenland from *Scotia* and other vessels, the fishery is regulated by quota and, in most years, these quotas are bought out by angling interests and not taken up.

Later in her first year of operation, from September to November 1972, *Scotia* took on a new but temporary role serving as a support ship off Iceland during the 'Second Cod War'. Iceland had taken unil-ateral action in extending her fishery limits, but British trawlers continued to fish there under the protection of the Royal Navy, harassed by Icelandic gunboats. *Scotia* provided medical and technical back-up for those fishing under these difficult conditions. She was fitted out with an emergency operating theatre, where the main computer was later positioned, and a dentist's chair was installed. The plankton laboratory formed a casualty reception area, with a large cast iron bath full of hot wax (to help revive hypothermia cases). Special showers enabled oil and other contaminants to be washed off injured survivors, and an X-ray facility was set up. *Scotia* carried a doctor and nurse during this period, but fortunately she never had to deal with anything more serious than toothache or minor cuts.

New developments

Scotia was one of the first ships to use a hydraulic crane to tow plankton nets and other sampling systems. Previously, such cranes had been used to lift equipment over the side, but not directly for towing. Progressively, during the life of the ship these cranes were upgraded three times, each time getting larger and more powerful. *Scotia* also adopted the on-board monitoring of surface temperature, salinity and seawater chemistry, by continuously measuring the characteristics of water pumped into the laboratories from an aperture in the ship's hull.

Scotia was also the first Marine Laboratory ship regularly to take female scientists to sea. Today, this is taken for granted.

During her successful 26-year working life *Scotia* continued the research into water circulation patterns around Scotland, pioneered by her predecessor. Results showed significant changes in the quantities of deep bottom water flowing from the Norwegian Sea into the North Atlantic. Fluxes of water from one area to another were measured using mechanical, electro-magnetic and acoustic current meters moored to the seabed. Large oceanic eddies were followed by the satellite tracking of drogues as they spun off to the north, this technique replacing the earlier method of the ship following a single drogue. The techniques employed in these studies would seem quite miraculous to William Bruce and his contemporaries. In her later years, the position of *Scotia* was routinely deter-mined with great accuracy using a global positioning system (GPS) where signals are sent to and received from satellites above the earth. The speed and direction of water currents beneath the ship were measured with an acoustic doppler current profiler. Electronic devices for measuring conductivity, temperature and depth (CTD probes) were applied in conjunction with electronically triggered

rosette water samplers, and replaced the water sampling bottle and reversing thermometer of earlier ships.

Scotia carried computers routinely, and much of the analysis formerly carried out by exercise of hand and brain was completed on board, rather than months or even years after completion of the cruise. The combination of electronic instruments with fast, powerful computers enabled much more information to be collected. In the 1950s, up to 12 readings of temperature and salinity were obtained at each isolated station. By the 1990s a CTD operating 25 times per second in 1,000 m of water would give about 90,000 measurements of pressure, temperature and salinity. An on-board computer could convert these measurements into values of temperature, density, speed of sound, geostrophic speeds and other parameters. A section across the Faroe–Shetland Channel could produce almost nine million values to process and plot, with the results available within a few hours of the ship completing the section.

Monitoring the seas around Scotland

Growing national and international concern about marine pollution, and the possible effects of contaminants on marine life, caused the third *Scotia* to play an increasingly important role in monitoring the chemistry of the seas around Scotland. From the 1970s *Scotia* conducted regular surveys of nutrients and contaminants, including metals, petroleum hydrocarbons, and man-made substances such as pesticides and chlorinated hydrocarbons. The demand for precise and accurate measurements of trace quantities of such substances saw the development of ever more complex methods of analysis. *Scotia* took part in the monitoring following a series of major pollution incidents, including the Piper Alpha fire in July 1988, the *Braer* stranding in 1993 and other major oil spills. The exploration and development of oil and gas reserves in the North Sea, and the construction of oil receiving terminals at Sullom Voe, Flotta, Nigg and the Firth of Forth, increased the potential for accidental spills and the risk of chronic environmental pollution. An increasing proportion of *Scotia*'s time was devoted to pollution surveys around the Scottish coast.

Young fish surveys

The third *Scotia* replaced not just the earlier ship of the same name but, particularly from 1984, she also took on the many routine trawling and sampling cruises formerly performed by *Explorer*, an Arctic trawler which had replaced an earlier ship of the same name in 1956. Her work included surveying the west coast of Scotland and North Sea for young fish, the triennial mackerel surveys, which took the ship from the coast of Norway down to the Bay of Biscay, and acoustic surveys for pelagic species of fish. As fish stocks became more heavily exploited, with some nearing the point of collapse, these independent surveys performed by *Scotia* became increasingly important to fisheries management.

Final years

Management of *Scotia* moved forward too, in line with the spirit of the age. In 1991, she was transferred, after public tendering, to be operated by a private company, Marr Vessel Management Ltd, which took over from the Fleet Support Unit of the Scottish Fishery Protection Agency. In May 1998 *Scotia* was sold to to an Italian company and sailed to Naples for conversion to a survey ship.

The latest *Scotia* undergoing sea trials off Aberdeen before beginning work for the Marine Laboratory

The new research ship Scotia

The latest ship to bear the name *Scotia* is a multi-purpose, 70 metre, diesel-electric vessel designed by Skipsteknisk A/S, of Alesund, Norway and built on the Clyde by Ferguson Shipbuilders Ltd of Port Glasgow. The design combines the essential features of a modern hydrographic research ship, with those of a top-line pelagic and demersal trawler.

Design features

The new *Scotia* is powered by three diesel engines, coupled to electrical generators supplying power to two electric propulsion motors which are arranged in tandem on a common drive shaft. With all three diesels running there is sufficient power to tow a large pelagic trawl for mackerel in winter conditions. The vessel travels between survey positions at 13 knots using only two diesel generators for economy, and can cruise on only one generator.

The ship has to operate close to fixed seabed positions and around structures like oil platforms. Her station-keeping abilities are maintained by a combination

of the single screw main power drive, an articulated rudder, an omni-directional bow thruster, and a tunnel stern thruster, steered by a dynamic global position fixing system operating through satellites above the earth.

The bridge of the ship allows all-round visibility. A fully instrumented autotrawl system facilitates fishing operations, locating the position of the trawl relative to the ship and measuring its dimensions, so reducing the potential for damage to the net. The trawl deck is visible both from the bridge and from a trawl control cabin at the aft end of the trawl deck. To enable the vessel to move quickly from one fishing gear to another a series of small hydraulic winches is fitted, so that trawl doors can be changed easily and safely. The two main trawl winches are situated below decks and are supplemented by two net drums above deck, and an auxiliary drum below deck, allowing net repairs to be carried out under cover.

Although the ship is fitted with a stern ramp for trawling, hydraulically operated ramp covers can be put in place, enabling hydrographic work to be carried out from a floor directly over the stern. A gamma frame allows equipment to be picked up from the deck and lowered over the stern and replaces the less versatile A-frame or simple davit of earlier ships. *Scotia* also has several large cranes and tension-compensated low pressure hydraulic winches to deploy, tow and recover scientific equipment. These specialised cranes allow instrument packages to be locked to the crane tips close to the sea surface, greatly reducing the potential for damage.

A drop keel can be lowered three metres beneath the hull of the ship, carrying acoustic transducers for echosounding and measuring ocean currents. The drop keel allows the systems to operate well away from the turbulence and entrained air close to the hull. The ship itself is very quiet, as much of the machinery is placed on resilient mounts, while the hydraulic systems operate under low pressure with large diameter pipework and bends of large radius.

Perhaps the most radical feature of the new *Scotia* is a system for locating container laboratories within the main body of the ship. Up to nine containers, five full-size and four half-size, can be loaded below decks and coupled to an umbilical carrying a full range of services. The laboratories can be adapted and fitted out on shore, at the Marine Laboratory, and a different combination loaded for each cruise.

The new *Scotia* maintains all the features of her predecessors. Although she would be unrecognisable to William Bruce and his scientists she has essentially the same characteristics as the first *Scotia*. She is able to operate in cold and inhospitable seas, carrying the most advanced scientific sampling systems of her day. She is set to maintain a proud tradition of service.

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Fisheries research in Scotland has a long tradition. It began over a century ago, in 1882, with the establishment of the Fishery Board for Scotland. Now the scientific programme is the responsibility of Fisheries Research Services (FRS), an Executive Agency of The Scottish Office Agriculture, Environment and Fisheries Department, established in April 1997.

Within FRS, marine research is carried out by The Marine Laboratory Aberdeen. The scientific programme of the Laboratory is directed at the sustainable development of living aquatic resources in the seas around Scotland.

The Marine Laboratory operates two research vessels, the *Scotia* and the *Clupea*

This booklet describes the four research ships which have operated under the name *Scotia*.

Marine Laboratory Aberdeen

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