The position of South Georgia on the Scotia Ridge, its isolation in the Southern Ocean and its unusual flora and fauna make the island a valuable site for many types of science. A German scientific expedition arrived as early as 1882 to make astronomical observations on the Transit of Venus and built a station in Royal Bay. Their reports on meteorology, geology, geomagnetism, glaciology and biology are the first systematic scientific observations from the island. Further work was undertaken by scientists on Otto Nordenskjöld’s Antarctic expedition in 1902, providing the first detailed descriptions of the range of plant communities.

The establishment of several whaling stations from 1904 onwards led to concern on the part of the British authorities about control and use of the catch. The legislation they enacted reflected a view that sustainability required full utilisation of the carcass and control over the number of companies taking whales. It became clear however that not enough was known about whale biology and the Southern Ocean for informed decision-taking. The Falkland Islands Dependencies therefore commissioned a series of long-term studies from 1925 to 1951 called the Discovery Investigations. Funded from a whale oil tax these investigations provided the first extensive documentation of the biology and oceanography of the waters around South Georgia. The many volumes of their reports are still the bedrock of much Southern Ocean science today. (See also the section on Discovery House on page 31.)

The Falkland Islands Dependencies Survey (FIDS) was involved in early work on the geology of the island and on the population biology of elephant seals, in the latter case to provide the authorities with a sustainable management plan to extract seal oil. By the early 1960s the British Antarctic Survey (BAS), the successor to FIDS, had begun work on sea birds and plant biology, and in 1969 established at King Edward Point (KEP) a multidisciplinary science programme which ran until 1982. Covering marine and terrestrial biology, bird and reindeer populations, geology, ionospherics and glaciology as well as maintaining the meteorology data this new initiative ranged across the whole island and provided a great deal of new data as well as maps.

Following the 1982 conflict science stopped for many years on the main island but in the 1990s small new biology programmes began working from Husvik. Meanwhile studies on birds and seals had continued without interruption at Bird Island. In addition BAS began a series of annual marine cruises around the island in the 1980s to establish patterns of change in the biology of key marine species, especially krill.

In 2001 the military garrison at KEP was replaced by a fisheries laboratory, run under contract by BAS, to provide advice to the South Georgia Government on the sustainable management of the fisheries around the island. Since then a variety of other science investigations by BAS and university scientists has been taking place to build further on the extensive data obtained in the earlier years.

Research

History of Science at South Georgia

The position of South Georgia on the Scotia Ridge, its isolation in the Southern Ocean and its unusual flora and fauna make the island a valuable site for many types of science. A German scientific expedition arrived as early as 1882 to make astronomical observations on the Transit of Venus and built a station in Royal Bay. Their reports on meteorology, geology, geomagnetism, glaciology and biology are the first systematic scientific observations from the island. Further work was undertaken by scientists on Otto Nordenskjöld’s Antarctic expedition in 1902, providing the first detailed descriptions of the range of plant communities.
Climate change: SCOTIA Centenary Antarctic Expedition

In 2002/03 a group of scientists travelled to South Georgia to celebrate the centenary of the Scottish National Antarctic Expedition to Antarctica. Its leader, William Bruce, was one of the first to realise the key role of the Southern Ocean in the global climate system, and the Scotia centenary team aimed to test recent ideas on past climate change in this region using a variety of techniques.

The aim was to determine the timing of past glacial retreat on the island and to test recent hypotheses that the Last Glacial Maximum ice sheet on South Georgia melted back earlier than was previously thought, perhaps as early as 18,000 years ago. This would indicate that South Georgia responded earlier than the northern hemisphere to the warming after the last glacial period, taking a leading role in climate change.

Various techniques were used to investigate the past glacial history of the island over thousands of years, including mapping the glacial geomorphology, taking sediment cores from the bottom of lakes to provide information about the timing of deglaciation, and analysing the sediments for records of other subsequent climate changes. Samples were also collected from glacial boulders for dating the advance and retreat of glaciers using a cosmogenic isotope technique.

Laboratory analyses continue but the team are currently working out when the ice receded and lakes were formed on South Georgia, and are working to understand environmental changes on the island in the post-glacial period. The expedition was sponsored by the Royal Scottish Geographical Society and the Carnegie Trust for the Universities of Scotland.

Mike Bentley
Lecturer, Department of Geography, University of Durham, UK

Tracking seabirds at sea

Albatross are the bird family most threatened with extinction and, since they are a major component of the bird diversity at South Georgia, a great deal of research has been focussed on their biology. The main risks to the birds are not on land but at sea where they die in their thousands in distant long-line fisheries (bird mortality has been virtually eradicated from South Georgia fisheries). Solutions to these problems require a detailed knowledge of the distribution of the birds throughout their lives and more especially information on their feeding areas. Modern technology has allowed the development of miniature electronic tags that can be attached to an albatross and report its position by satellite.

Whilst this work is being undertaken from many of the Southern Ocean islands, Bird Island has provided important data for three species – wandering albatross, grey-headed albatross and black-browed albatross. The present efforts to mitigate the decline of these beautiful birds relies heavily on proof of the overlap between fishing and bird feeding, especially on the continental shelf of South America.

Vicki Auld

Moraine Fjord from Greene Peninsula. The moraines on the left hillside record at least two former expansions of the Harker Glacier in the background
Mike Bentley
Marine diversity around South Georgia

The land and lakes of South Georgia are sub-Antarctic in character and biota, but its marine biology more closely resembles that of the Antarctic Peninsula area.

As such, South Georgia represents the most northerly limit for many Antarctic marine organisms. Life in both the water column and sea bed around the island is very abundant and rich. From just a few meters depth to hundreds of metres the sea bed is patchily carpeted with ascidians (sea squirts), bryozoa, cnidarians (corals, anemones and hydranths), crustaceans (though not barnacles or true crabs), echinoderms (sea stars, brittle stars, feather stars, sea urchins and sea cucumbers), molluscs, pycnogonids (sea spiders), sponges and a wide variety of worms. Some coastal sites protected from iceberg damage have spectacular assemblages of giant and old animals. A few hundred meters down, large stone crabs (lithodids) also wander the bottom amidst sea lilies (crinoids) and basket stars.

Most marine species in South Georgia waters do not occur outside the Southern Ocean and many only occur around the island itself (endemics). Of the 199 mollusc species known there, 65 are endemic and 12 of the 97 cheilostome bryozoans are endemic.

Most Antarctic invertebrates are thought to be very stenothermal, which means that they are tolerant of only narrow temperature ranges. As South Georgia is in one of the most rapidly warming regions in the world, it is an obvious locality to watch for marine biological responses to climate change.

Despite being such a pivotal location for Antarctic marine biodiversity, very little is known about life on the sea bed surrounding South Georgia and new species are often discovered.

David Barnes
Biologist, British Antarctic Survey

Recently discovered sea star
Guillermo Moreno
Geology: linking tectonics and biology

South Georgia is a fragment of continental crust that originated from a position between the tips of South America and the Antarctic Peninsula when they formed part of a continuous landmass (Gondwana) that existed 50 million years ago. As this landmass separated and the ocean floor of the Scotia Sea formed, South Georgia became transported to its present day position along the Scotia Arc (see page 15). Attempts to model the evolving distribution of ancient landmasses and oceanic seaways of the Scotia Sea during this period suggest that the slow movement of South Georgia was accompanied by the development of narrow, shallow seaways before eventual isolation of the continental fragment by deep water seaways. The timing of the development of seaways of varying depths and the presence or absence of emergent landmasses is crucial for evolutionary studies of sub-Antarctic marine and terrestrial biota within the Scotia Sea region.

Current geological research on South Georgia aims to provide a detailed understanding of the tectonic history of the island by dating tectonic events that have shaped the geology of the island as well as determining the timing of tectonic uplift to establish how long the current mountainous landscape has been present. The results of this dating programme will be used to test and constrain models of Scotia Sea evolution. In addition, analysis of specific minerals that have grown during periods of tectonic deformation will help to determine if the island has always been above the surface of the ocean or whether it has spent periods submerged beneath the waves. The result will provide critical information for constraining habitat availability.

Mike Curtis
Geologist, British Antarctic Survey

Seismics: Hope station at Hut Point

South Georgia is situated on the Scotia Arc near the tectonically active South Sandwich Islands and is therefore a significant place for studying seismic activity.

The HOPE station at Hut Point, around 500m east of King Edward Point, is part of the Global Seismographic Network (GSN) of over 100 seismometers worldwide. It is maintained through an agreement between the British Antarctic Survey, who provide logistic and local support, and the Incorporated Research Institutions for Seismology project International Deployment of Seismometers (IRIS/IDA) based in California, who provide the equipment and distribute and archive the data.

Small tremors are recorded daily with occasional larger shocks from the South Sandwich region. Seismic waves from the opposite side of the world are detected and HOPE is ideally placed to detect earthquakes from around Japan and the Kurile Islands. The data enable seismologists to research the composition of the interior of the Earth and processes that take place within it. The network also provides information that is useful for earthquake and tsunami hazard assessments. As stations can only be sited on land it is not possible to have an even network of stations. Stations on remote islands such as South Georgia are therefore particularly important.

Rob Larter
Marine Geophysicist, British Antarctic Survey
Modelling the Southern Ocean

Ocean ecosystems play a crucial role in maintaining biodiversity, in depositing carbon into the deep ocean and as a source of protein for humans. However, fishing and climate change are having significant effects on the Southern Ocean ecosystem.

In order to assess these effects and the implications for the future, scientists are developing computer models which can predict biological and physical processes locally around South Georgia and on a larger scale. The aim is to identify, quantify and model key interactions and processes on scales that range from microscopic life forms to higher predators such as penguins, albatross, seals and whales.

For example, computer models are being used to look at how ocean currents affect the distribution of Antarctic krill. Satellite sea ice motion data are used to simulate the effect of the presence of sea ice on the pathways of the krill. A decline in krill, which

Hydrography and HMS Endurance

HMS Endurance is the Royal Navy's ice patrol and hydrographic surveying ship. She supports British interests in Antarctic waters and especially around the Antarctic Peninsula, South Georgia and the South Sandwich Islands.

HMS Endurance conducts hydrographic surveys in deep water oceans and inshore waters in regions which are still largely uncharted. She has recently been fitted with a 'state of the art' Multi Beam Echo Sounder, which surveys at five times the efficiency of her previous equipment and with greater resolution, generating highly detailed 3-D images of the sea bed. In addition, inshore survey work is conducted using two survey motor boats. The data gathered are processed onboard and sent to the UK Hydrographic Office, where they are incorporated into charts used by mariners around the world. Endurance's work therefore makes a significant contribution to the safe navigation of other vessels visiting the region.

Endurance usually visits South Georgia every austral summer and, as well as hydrographic surveys, conducts a varied programme of work. The two Lynx helicopters are used for transporting survey and scientific teams, supplies and equipment. Support has been given to the South Georgia Government, British Antarctic Survey, the British Schools Expedition Society and the South Georgia Heritage Trust. The Royal Marine Detachment also undertakes training and patrols ashore from time to time, including walking the Shackleton Route across the island.

For further information on HMS Endurance see www.visitandlearn.co.uk

Nick Lambert
Captain, HMS Endurance

Satellite image from January 2004 showing a major phytoplankton bloom (pale blue) north of South Georgia (bottom centre)

NASA Earth Observatory, www.earthobservatory.nasa.gov

HMS Endurance in South Georgia
David Nicholls
Bird Island

Bird Island lies off the north-west tip of South Georgia with a coastline of sheer cliffs and rocky beaches. The island is 5km long, up to 800m wide with its lower slopes covered with tussac grass with rock, scree and mosses above this altitude. There is no permanent snow or ice on the island; the yearly temperature range is from -10°C to +10°C.

Scientifically, its rich diversity of wildlife and absence of rats make it an ideal place for research on birds and seals. Home to about 50,000 breeding pairs of penguins, 14,000 pairs of albatrosses, over 700,000 nocturnal petrels and at least 65,000 fur seals, it is a crowded place.

The first permanent hut at Bird Island was established in 1958 by the Falkland Islands Government. A living hut and two further small huts were added in 1963 by the United States Antarctic Research Programme. The British Antarctic Survey has supported summer work on the populations of birds and seals since 1971. A new hut was built in 1981/82 and facilities were further improved in the mid-1990s. Recent redevelopment has demolished all the old buildings and provided purpose-built modern facilities for ten staff in summer, reducing to four in winter.

The research programmes on Bird Island focus on seabird and seal population dynamics, feeding ecology and reproductive performance. A long-term monitoring study delivers data for international marine management and conservation objectives, including the CCAMLR Ecosystem Monitoring Programme.

feed on algae under the sea ice during the winter, has been linked to lower sea ice concentrations.

Shipboard research includes measurements of temperature and salinity from the surface to the ocean bed; measurement of ocean currents and mapping the distribution of plankton, fish and squid using sensory and acoustic systems; and catching biological specimens using nets. At Bird Island, penguins, albatross and fur seals are studied year-round to assess breeding performance, growth, diet and foraging.

These studies feed into the models of biological and physical processes and can be used as a basis for sustainable management. The challenge is to predict how human activity and climate change will affect this environment and how biological communities will respond.
Research Policies

Aim: Encourage high quality research to enhance understanding of South Georgia’s history and natural environment and contribute to regional and global conservation

Permit applications
- Private visitors undertaking research must complete the visitor/expedition application forms as appropriate. In addition, specific information for research applications including detailed project proposals and a Preliminary Assessment of environmental impacts must be supplied to the South Georgia Government (see South Georgia website for details)
- Government-funded researchers (ie. British Antarctic Survey (BAS), Sea Mammal Research Unit, Universities) must notify the South Georgia Government of all plans for scientific activities, particularly land-based research beyond research stations. Environmental assessments may be required by the Government before allowing activities to go ahead
- Where research has not undergone a formal peer-review process, proposals may be submitted to a panel of experts
- The South Georgia ethical code must be followed at all times (see South Georgia website)
- Post visit reports must be completed for all scientific activities outside research stations

Reporting and availability of data
- A description of science projects will be put on the South Georgia website
- It is a condition of permit that information on research be submitted after completion (even if not published)
- All published papers should be submitted to the Government on publication
- A database for South Georgia is to be developed and will include a bibliography and links to papers and reports where possible. The database will be hosted by BAS

Albatross at Bird Island
Simon Pickering

For further information about South Georgia, please visit our website www.sgisland.org