

Important Bird Areas

South Georgia

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Bruce Pearson

South Georgia from the sea; a typical first view of the island.

Abstract The mountainous island of South Georgia, situated in the cold but productive waters of the Southern Ocean, is a UK Overseas Territory and one of the world's most important seabird islands. It is estimated that over 100 million seabirds are based there, while there may have been an order of magnitude more before the introduction of rats. South Georgia has 29 species of breeding bird, and is the world's most important breeding site for six species (Macaroni Penguin *Eudyptes chrysolophus*, Grey-headed Albatross *Thalassarche chrysostoma*, Northern Giant Petrel *Macronectes halli*, Antarctic Prion *Pachyptila desolata*, White-chinned Petrel *Procellaria aequinoctialis* and Common Diving Petrel *Pelecanoides urinatrix*). Several of the key species are globally threatened or near-threatened, which emphasises the need for action to improve the conservation status of the island's birds. South Georgia is currently classified by BirdLife International as a single Important Bird Area (IBA) but it may be better considered as comprising several distinct IBAs. Current threats to the South Georgia avifauna include rats (a major campaign to eliminate rats began in 2010/11), regional climate change, and incidental mortality in longline and trawl fisheries. Local fisheries are now well regulated but South Georgia albatrosses and petrels are still killed in large numbers in more distant fisheries.

This paper is dedicated to the memory of Peter Prince (1948–1998), who worked on South Georgia from 1971. His enthusiasm and commitment to the development of Antarctic ornithology was unbounded and left an indelible impression on all who were lucky enough to know and work with him. See plate 89, p. 144.

Introduction

Isolated, mountainous and surrounded by the tempestuous waters of the Southern Ocean, South Georgia has long fascinated biologists and travellers alike. In the late nineteenth and early twentieth centuries the island was the site of industrial-scale exploitation of marine mammals and seabirds, but nowadays it is a location for important biological work and is much visited by tourists attracted by the wealth of wildlife set in spectacular scenery. The occasional tourist visited South Georgia from the early twentieth century, but the start of modern tourism was the arrival of the *Lindblad Explorer*, a vessel constructed explicitly for polar tourism, in 1970. This was joined by *World Discoverer* in the 1977/78 season, and by the early 1990s several vessels were including South Georgia on their Antarctic itineraries (Poncet & Crosbie 2005). Modern ship-based tourism has thus brought the wildlife riches of South Georgia within the reach of many birders.

South Georgia lies between latitudes 53°S and 55°S, and between longitudes 34°W and 42°W. It is extremely isolated, and lies about

1,400 km ESE of the Falkland Islands, 1,550 km northeast of the nearest point on the Antarctic continent, 2,150 km east of South America and 4,800 km from South Africa. The main island of South Georgia is 170 km long and 2–40 km wide, and is orientated northwest to southeast. It is surrounded by over 70 islands, islets, stacks and rocks. The larger offshore islands are well vegetated and hold important populations of breeding seabirds. They include Willis Islands and Bird Island off the northwest extremity, Cooper Island off the southeast extremity, and Annenkov Island, 15 km off the central southwest coast (fig. 1). Further away lie Shag Rocks, 250 km west of the island, and Clerke Rocks, 75 km east of the southeast end. Both are topographically part of the South Georgia continental shelf, and hence are considered with ‘mainland’ South Georgia in this article.

South Georgia is the highest of all the sub-antarctic islands and has a landscape dominated by spectacular alpine topography. The central backbone of the island is formed by the Allardyce and Salvesen Ranges, and these separate two coasts of contrasting topography and

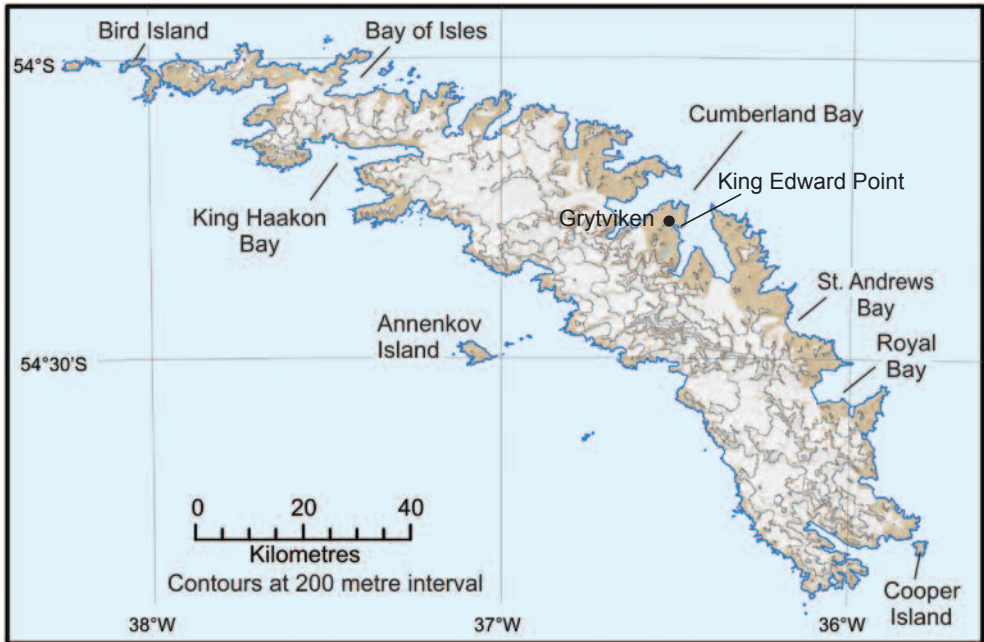


Fig. 1. A map of South Georgia showing the distribution of permanent snow and ice, and some key locations mentioned in the text.

climate. There are at least 20 peaks over 2,000 m, the highest being Mt Paget (2,934 m). Much of the land is over 1,000 m in altitude; at least half is covered in permanent ice and snow and there are more than 160 glaciers. The southern coastline is fully exposed to the prevailing westerly weather systems and is therefore colder, wetter and more heavily glaciated than the northern coastline. The southern coastline is predominantly rock and ice, with permanent snow and ice starting at 300 m altitude, and lowland areas covered with extensive tussock grassland are uncommon. In contrast, the northern coast is more sheltered, with a permanent snowline starting at 400–600 m altitude, and has extensive ice-free vegetated peninsulas bounded by glaciers, many of which now terminate on land.

Geological and oceanographic setting

Geologically, South Georgia forms part of the great mountain chain that once bordered the vast continental landmass of Gondwana. Its origins are therefore linked to both the Andes

and the Transantarctic Mountains. Tectonic forces have, however, fragmented this chain of mountains into the string of islands that nowadays forms the Scotia arc. The bulk of South Georgia is formed of sandstones and mudstones, the alternation of which gives the area of the Allardye Range its striped appearance, although the Barff Peninsula south to Gold Harbour comprises quartz-rich sandstones. The southern corner is very different geologically, being formed by massive igneous or metamorphic rocks deriving from the edge of Gondwana and pierced by many doleritic volcanic dykes. This lends a harsh and stark aspect to a landscape dominated by snow- and ice-clad mountains.

Oceanographically, South Georgia lies in the path of the Antarctic Circumpolar Current, which flows clockwise (eastwards) around Antarctica between latitudes 50° and 60°S, driven by the predominantly westerly winds. These eastward-flowing Antarctic waters have surface temperatures between 0°C and 4°C. In the area of the Scotia Sea, the flow of this powerful current is constrained by the

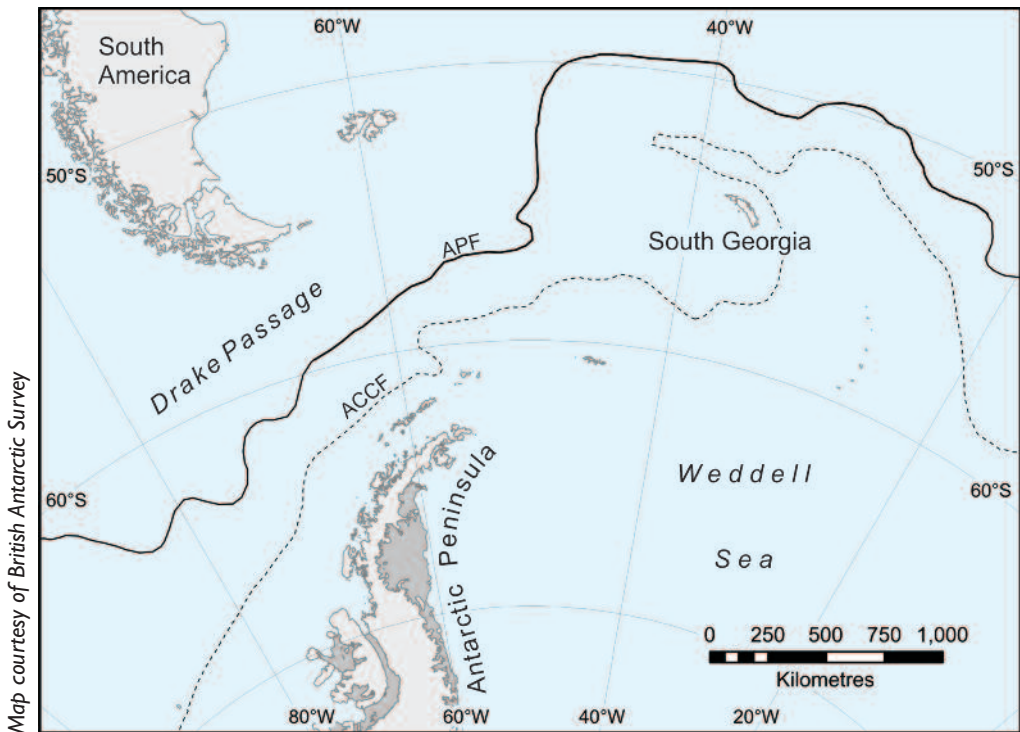


Fig. 2. The oceanographic setting of South Georgia. The Antarctic Polar Front (APF) marks the northernmost limit of the Southern Ocean, and thus defines the Antarctic faunal zone. The ACCF is the oceanographic front that marks the southern boundary of the Antarctic Circumpolar Current.

bottleneck of the Drake Passage and the extensive undersea ridge of the Scotia arc. Within the Antarctic Circumpolar Current lies a sharp discontinuity in ocean surface temperature, the Antarctic Polar Front (fig. 2). Surface temperature drops markedly across this front, and as a result this region is characterised by frequent fogs. The Antarctic Polar Front delimits the Southern Ocean, and thus defines the area of ocean that can be called Antarctic. It forms the natural boundary of an Antarctic faunal zone, though being a mobile oceanographic feature it is perhaps more difficult to use than the simple latitudinal definitions adopted by many birders.

Of major biological significance to the South Georgia marine ecosystem is the area to the northeast of the island where the relatively warmer waters of the Antarctic Circumpolar Current meet colder waters that originate in the Weddell Sea to the south and southeast of the island. Biological productivity is further enriched by favourable oceanic conditions created at the edge of the continental shelf, where depths drop rapidly to over 3,000 m. The continental shelf itself is relatively wide, extending for 50–150 km from the island. The shelf is mostly less than 200 m deep, except for the deep submarine canyons, which are the offshore extensions of many of the glaciated fjords on the island. The South Georgia marine system is very rich biologically. Not only do the prevailing currents carry substantial quantities of Antarctic Krill *Euphausia superba* to the area, but the seas also support significant local production. The rich seabird populations of South Georgia are thus related to a suite of characteristics: an extensive area of suitable breeding habitat, an abundant local supply of food for species foraging close to the island, but with ready access to other rich feeding areas such as the Patagonian Shelf, the Falklands Current, and even the Benguela upwelling and the Scotia and Weddell Seas for those species able to undertake longer foraging trips.

A brief history of South Georgia

As with so many isolated islands, we will probably never know who first sighted South Georgia. It is possible that it was seen as early as the sixteenth century from sailing ships

blown off course by storms while making the perilous rounding of Cape Horn, but the first sighting on record was made by a London merchant, Antoine de la Roché, in April 1695 (Headland 1984). The next sighting was probably made by French merchants aboard the Spanish ship *Léon*, which was also blown off course, in 1756. The island was named Isla de San Pedro (or Île de St Pierre) after the saint's feast day. Both its mountainous nature and its abundant wildlife were noted.

Two decades later, South Georgia was mapped and explored by Captain James Cook on the second of his three voyages on HMS *Resolution*. The first sighting was by Midshipman Willis on 14th January 1775, and the next day Cook saw and named Bird Island 'on account of the vast numbers that were upon it'. Three days later *Resolution* hove to at the entrance to what is now Possession Bay on the north side of the island. Cook lowered a small boat and went ashore with a midshipman and three naturalists (John Forster, George Forster and Anders Sparrman). The landing was probably in Prince Olav Harbour; here Cook took possession of the island in the name of King George III with a display of flags and discharge of firearms. Although Cook was famously unimpressed with South Georgia, his account of the voyage, published in 1777, described the large numbers of seals to be found there and thus triggered the first wave of exploitation of the island's natural resources.

Although the coastline of South Georgia had soon been relatively well charted by whalers and others, the interior was largely unknown. This was rectified by the four expeditions of the South Georgia Surveys (1951/52, 1953/54, 1955/56 and 1956/57) under the leadership of Duncan Carse.

Detailed scientific work on South Georgia started with the occupation of a research station in Royal Bay by the German International Polar Year Expedition in 1882–83, which was the first scientific party to overwinter on the island. From 1925 to 1931 the *Discovery* Investigations occupied a laboratory (Discovery House) on King Edward Point. The scientific staff made anatomical investigations of whale carcasses brought into Grytviken as part of a wider, long-term study of whale populations and the ecology of the

Southern Ocean that had the ultimate objective of providing a basis for the sustainable harvesting of whales (Hardy 1967).

The British Antarctic Survey (BAS) established a scientific research station at King Edward Point in 1969, working initially from the old *Discovery* Investigations building. A detailed study of Antarctic Fur Seals *Arctocephalus gazella* and seabirds had started previously on Bird Island in the 1950s and BAS research on Bird Island was started as a summer-only operation in 1971. A year-round station was built in 1983 and has been in continuous operation ever since.

In 1908 South Georgia was included within the Falkland Islands Dependencies and a resident magistrate took office at Grytviken to oversee the whaling industry that was now subject to regulation and taxes by the Falkland Islands Government. The magistrate moved to nearby King Edward Point in 1912. British government of South Georgia was interrupted by the occupation by Argentine forces for 22 days in 1982, after which a British garrison was established at King Edward Point. South Georgia and the South Sandwich Islands became a British Overseas Territory in 1985, and in 2001 the military garrison was replaced by the BAS.

The history of South Georgia is described by Headland (1984), Burton (1996) and Poncet & Crosbie (2005).

Exploitation of South Georgia

South Georgia has a long history of exploitation by humans, and has had the longest period of continuous human habitation of all the subantarctic islands. The hunting of Antarctic Fur Seals and Southern Elephant Seals *Mirounga leonina* started just over a decade after Cook's voyage, with the arrival of the British vessel *Lord Hawkesbury* in 1786. The first American sealing vessels arrived in 1792, and in the 1800/01 season 17 sealing vessels took a record 112,000 pelts of Antarctic Fur Seals from South Georgia alone. Exploitation was so intense that by 1835 the industry collapsed through over-harvesting. Residual hunting continued and, by the time of the visit of zoologist Robert Cushman Murphy, on the American whaling brig *Daisy* in 1912/13, the Antarctic Fur Seal was believed to have been hunted almost to

extinction. In the 1930s, small numbers were found breeding on Bird Island (Bonner 1968). For many years the population remained at very low levels, but in the second half of the twentieth century the population recovered spectacularly (Boyd 1993), possibly aided by an increased availability of Antarctic Krill following the exploitation of the great whales. The Antarctic Fur Seal has thus gone from being one of the rarest large wild mammals to one of the most abundant on the planet.

Southern Elephant Seals were also hunted, but for their oil rather than skins. As with Antarctic Fur Seals, hunting was initially completely unregulated. In 1904, the newly established whaling station at Grytviken started elephant-sealing as a sideline and regulation by quotas and a close season was introduced in 1909. A scientific study in 1952 by the Falkland Islands Government Sealing Inspector, Richard Laws, established a sustainable harvesting regime which continued until the closure of the whaling station. It remains a rare example of the rational use of living resources in an otherwise depressing catalogue of commercial exploitation. It has often been stated that King Penguins *Aptenodytes patagonicus* were also exploited for oil at South Georgia, based essentially on comments by Harrison Matthews (1931) and Murphy (1948), and it has long been assumed that the local population is recovering from a historical low level caused directly by this exploitation. While King Penguins undoubtedly were exploited elsewhere, notably at Heard Island, the evidence that there was extensive exploitation at South Georgia remains frustratingly anecdotal.

Shore-based whaling started in November 1904 (plate 74), and continued until December 1965. At the peak there were six whaling stations operating on South Georgia. In 1925/26, the advent of pelagic whale factory ships, in which carcasses could be drawn onto the deck for processing, liberated the whaling companies from restrictions and taxes imposed by the Falkland Islands. The result was a sharp increase in the exploitation of baleen whales and a reduction in stocks. The first species to suffer a decline in numbers was the Humpback Whale *Megaptera novaeangliae*. This was followed by



British Antarctic Survey

74. A shoreline at South Georgia littered with whalebones emanating from the earliest days of shore-based whaling, when carcasses were flensed on the shore.

Blue *Balaenoptera musculus* and Fin Whales *B. physalus*; numbers of both species recovered somewhat during the Second World War, but following the resumption of whaling, first the fishery for Blue Whales then Fin Whales collapsed. Attention was then directed to the smaller Sei Whale *B. borealis*, until this too was reduced in numbers. Whaling from shore stations on South Georgia eventually became economically unviable, and the last whaling station on South Georgia, Leith Harbour, closed in December 1965. Pelagic whaling continued, however, and the industry finally turned to harvesting the smallest of the rorqual whales, the Antarctic Minke Whale *B. bonaerensis*.

The whaling stations are now derelict and out of bounds to visitors because of health and safety considerations. To address these issues at Grytviken, the South Georgia Government undertook a programme of building removal there in 2003 and 2004; now, apart from the church and a few buildings, including the South Georgia Museum (previously the manager's villa), only the rusting machinery stands.

Fishing started in the late 1960s with Soviet and Eastern Bloc vessels taking Antarctic Krill and Marbled Rock-cod *Notothenia rossii*. Stocks of the latter rapidly

became depleted and the population has yet to recover. Fishing activity has continued, though regulated by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) since 1982. Current fisheries around South Georgia are longlining for Patagonian Toothfish *Dissostichus eleginoides*, mid-water trawling for Mackerel Ice-fish *Champsocephalus gunnari* and Antarctic Krill, and experimental pot-fishing for anomuran crabs. Fishing vessels are licensed, and Total Allowable Catches (TACs) set by CCAMLR are enforced within the 200-nautical-mile South Georgia Maritime Zone. Measures to prevent albatrosses and other seabirds being caught on longlines are mandatory.

The influence of humans on land has been predominantly through the introduction of alien fauna and flora. Reindeer *Rangifer tarandus* were introduced by the whalers as a source of food. There were two separate introductions: Ocean Harbour and Stromness Bay in 1911, and a repeat introduction at Stromness Bay in 1925 after the original animals all died in an avalanche (Leader-Williams 1988). There are now two populations, one ranging from the Barff Peninsula to Royal Bay and the other inhabiting most of the Lewin (Busen) Peninsula, including Stromness Bay and

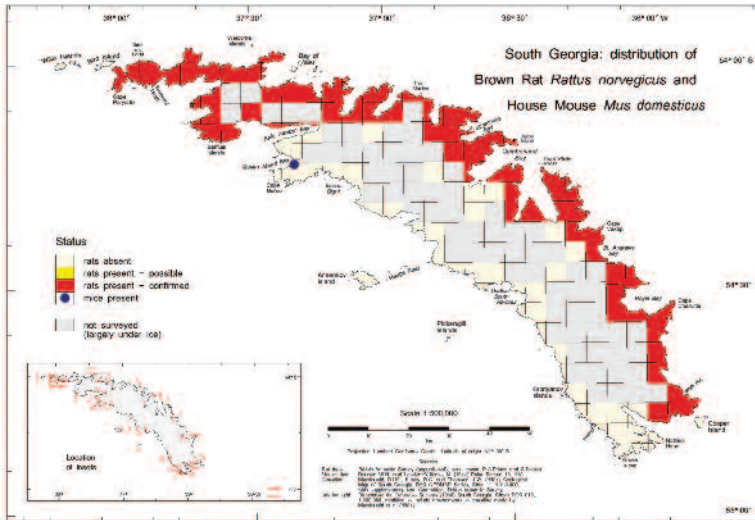


Fig. 3. Distribution of Brown Rat *Rattus norvegicus* and House Mouse *Mus domesticus* on South Georgia. Reproduced with permission from Trathan et al. (1996).

Fortuna Bay. The total population is currently unknown but is probably around 3,000 animals, and both the flora and the landscape have been extensively modified by their activities. In particular, they have overgrazed the extensive coastal stands of Tussac Grass *Poa flabellata* and Greater Burnet *Acaena magellanica*, together with various species of lichen, and their selective grazing habits have encouraged the spread of the introduced Annual Meadow-grass *Poa annua*.

Horses, sheep, pigs, cats, dogs and other domestic animals were kept at the whaling stations but are no longer present and none is known to have caused any significant environmental impact. In contrast, the environment of large areas of South Georgia has been modified by the introduction of the Brown Rat *Rattus norvegicus*. Rats are thought to have been introduced accidentally by sealing vessels in the late 1700s, and now occupy virtually the entire northeast coastline and the northern quarter of the southwest coast (fig. 3). In rat-infested coastal areas, South Georgia Pipits *Anthus antarcticus* and the smaller burrowing petrel species have been eliminated, while populations of both White-chinned Petrels *Procellaria aequinoctialis* and South Georgia (Yellow-billed) Pintails *Anas georgica georgica* have been greatly affected.

It is not known when or how the House Mouse *Mus domesticus* was introduced. Until

recently, mice were known from four locations: the north and south shores of Shallop Cove, Holmestrand and Cape Rosa. The areas now designated as mouse-infested are the entire Nuñez Peninsula and the coast from Shallop Cove to Cape Rosa to the south coast of King Haakon Bay. In areas where mice are present, populations of

Pipit appear to be significantly lower than in similar, mouse-free parts of the island.

The terrestrial environment

South Georgia's high-altitude, glaciated interior, together with its position south of the Antarctic Polar Front and surrounded by cold Antarctic waters, results in a cooler oceanic climate than characterises most other subantarctic islands, and a harsher climate than would be expected from its latitude alone. The mountainous nature and complex topography of the island mean that the weather can change rapidly and also differs greatly in adjacent fjords. The orographic effects of the island's central mountain ranges greatly influence regional precipitation and weather. The southwest side and the extremities of the island, being exposed to the prevailing westerly weather systems, are typically cold, wet and cloudy with strong winds. The northeast coastal areas are more temperate, being sheltered by the mountain ranges and local topography. Here, the average annual precipitation is 1,600 mm, annual wind speed is 4.4 m per second, and mean annual temperature is +2°C with an absolute range of -19°C to +24°C. Winter and summer seasons are clearly defined, with mean temperatures of +4.8°C in the summer and -1.2°C in winter with significant winter snowfall down to sea level. Föhn winds associated with passing frontal systems frequently

produce localised rapid increases in temperature (and may exceed 100 knots).

The terrestrial environment of South Georgia shows a strong altitudinal zonation, which has considerable importance for the distribution of breeding birds. At lower levels the vegetation can be lush, and in the natural state is dominated by Tussac Grass. Where Reindeer have been introduced, much of this tussac grassland is greatly reduced in extent by grazing, and survives only on the steeper slopes. In addition, where Antarctic Fur Seals come ashore to breed, the tussac grassland is also heavily eroded.

There are 24 species of vascular plants native to South Georgia, together with about 125 species of mosses, 80 of liverworts and 150 of lichens. There are no trees or shrubs, and only mosses and lichens survive in the inland rock and ice environment. There are over 50 naturalised introduced vascular plant species, which occur mostly around the old whaling stations.

Extensive areas of vascular vegetation are confined principally to low-altitude coastal areas and offshore islands, islets and stacks, where the landscape is dominated by tussac grassland, which extends from sea level to a maximum altitude of 200 m on the south coast and 400 m on the north coast. *Festuca* grassland, dominated by Tufted Fescue Grass *F. contracta*, is widespread up to 200-m altitude on coastal areas of the central north coast, and stands of Greater Burnet occur most frequently in sheltered damp tussac grassland but are absent in grazed areas. Mire and bog communities dominated by Greater Rush *Juncus scheuchzeroides* and Brown Rush

Rostkovia magellanica occur wherever there are seepage slopes, streams and springs. Fell-field communities consisting of scattered mosses, lichens and various vascular plants occur on dry stony ground in exposed windswept sites on the coast and on inland plateaux and mountain ridges. There are no indigenous terrestrial mammals, reptiles, amphibians or freshwater fish. The terrestrial and freshwater invertebrate fauna is limited in terms of numbers and species diversity. It includes flies, beetles, springtails, mites, ticks, spiders, annelid worms and a land snail.

A history of the ornithology of South Georgia

The South Georgia avifauna was reviewed by a number of biologists from early expeditions and summarised by Harrison Matthews



Andrew Clarke

75. The King Penguin *Aptenodytes patagonicus* was one of the first species to be the subject of detailed study at South Georgia.

(1929), but the first major study of South Georgia seabirds was that by the American ornithologist Robert Cushman Murphy, who visited the island aboard the whaling brig *Daisy* in 1912–13. This work contributed to the seminal *Oceanic Birds of South America* (Murphy 1936), and was portrayed delightfully in letters written back to his newly-wed wife and published as *Logbook for Grace* (Murphy 1948).

A number of subsequent visitors to the island recorded ornithological observations (e.g. Rankin 1951) and Bernard Stonehouse studied the breeding of King Penguins (plate 75) from October 1953 to December 1954 at the Bay of Isles. The next period of ornithological research ashore on South Georgia was that by USARP (United States Antarctic Research Program)-funded scientists, led by Lance Tickell, on albatrosses at Bird Island between 1958 and 1964. This work established the basis for the first long-term studies of the seabird populations of South Georgia, and some of the birds ringed then are still breeding on Bird Island today. Bird Island was reoccupied by scientists from the BAS in 1971, and extensive ornithological work carried out every austral summer until 1981/82 (except 1974/75). The conflict with Argentina led to the evacuation of the station and cessation of scientific work between

April and September 1982, since when ornithological research has continued uninterrupted.

Although ornithological work on South Georgia has concentrated on Bird Island, a number of all-island surveys of breeding seabirds have been carried out, notably albatrosses in 1986/87, 1987/88 and 2003/04; giant petrels in 1986/87, 1987/88, 2005/06 and 2006/07; and White-chinned Petrels in 2005/06 and 2006/07. The British Antarctic Survey's South Georgia Breeding Birds Survey, which operated from 1985 to 1988, resulted in the first island-wide bird population estimates. Co-ordinated by Peter Prince, the fieldwork was conducted from the yacht *Damien II*, with landings at hundreds of sites around the island. Additionally, Sally Poncet, working from the yachts *Damien II* and *Golden Fleece*, has recorded breeding birds throughout the island from the 1970s to the present day.

During the past 25 years, there have thus been major advances in our knowledge of the distribution of all bird species on South Georgia. We now have reasonable estimates for the abundance of most of the larger species such as albatrosses and penguins, yet for many of the rest we know no more than we did 40 years ago. This applies in particular to the smaller petrels, and especially the bur-

rowing petrels, for which the best data are often those summarised by Prince & Payne (1979).

Over the period that ornithological work has been undertaken on Bird Island, ornithologists and others have recorded seabirds at sea around South Georgia, with records from BAS and its predecessor (the Falkland Islands Dependencies Survey, FIDS) going back to 1959.



Tony Martin

76. The endemic South Georgia race of the Yellow-billed Pintail *Anas georgica*.

Table 1. Breeding birds of South Georgia. The figures for breeding population are rounded, and the date is of the most recent census or estimate. Note that occasional breeders (Adélie Penguin, Southern Rockhopper Penguin, White-capped Albatross) have not been listed; these are shown in table 2. Note that for species where only part of the population breeds each year (King Penguin, Wandering Albatross, Grey-headed Albatross and Light-mantled Albatross) the census data are uncorrected for non-breeding birds. nd: no data. IUCN abbreviations: LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered. Scientific names appear in the text.

Species	Estimated breeding population (pairs)	Date of most recent census or estimate	Percentage of world population (estimated)	IUCN status
Yellow-billed Teal	<20	2011	nd	LC
South Georgia Pintail	6,000	2011	nd/endemic	LC
King Penguin	>450,000	2002	45	LC
Gentoo Penguin	105,000	1996	30	NT
Chinstrap Penguin	12,000	1987	<1	LC
Macaroni Penguin	<1,000,000	2005	20	VU
Wandering Albatross	1,550	2004	12	VU
Light-mantled Albatross	5,000	1976	20	NT
Grey-headed Albatross	47,700	2004	40	VU
Black-browed Albatross	74,300	2004	12	EN
Southern Giant Petrel	8,700	2007	15	LC
Northern Giant Petrel	17,200	2007	45	LC
Cape Petrel	10,000	2010	1	LC
Snow Petrel	3,000	1983	<1	LC
Blue Petrel	70,000	1983	5	LC
Antarctic Prion	22,000,000	1983	>85	LC
Fairy Prion	1,000	1983	<1	LC
White-chinned Petrel	900,000	2008	50	VU
Wilson's Storm-petrel	600,000	1983	5–10	LC
Grey-backed Storm-petrel	Unknown (<100)	2004	nd (<1)	LC
Black-bellied Storm-petrel	10,000	1983	40	LC
South Georgia Diving Petrel	2,000,000	1983	30	LC
Common Diving Petrel	3,800,000	1983	50	LC
Imperial Shag	10,300	1987	<5	LC
Snowy Sheathbill	2,000	1983	20	LC
Kelp Gull	2,000	1983	<1	LC
Antarctic Tern	2,500	1983	15	LC
Brown Skua	2,000	1983	10–20	LC
South Georgia Pipit	3,000	1983	endemic	NT

During this period, non-breeding visitors and vagrants were also recorded, and an informal database maintained by BAS. This, together with previous records compiled in the Antarctic Map Folio Series (Watson *et al.* 1971), was used as the basis for the summaries of the South Georgia avifauna by Prince & Payne (1979) and Prince & Croxall (1983, 1996). Since then the number of observers in the South Georgia area has

increased dramatically with ship-based tourism, but in the absence of a system for documenting these observations, most of these sightings remain unreported or unavailable for review.

The breeding birds of South Georgia

The current status of the 29 species known to be breeding regularly on South Georgia is

We use the taxonomic sequence recommended by the IOC (Gill & Wright 2006). For the taxonomy and nomenclature of species whose breeding range is primarily South American, we follow the South American Classification Committee (SACC) (www.museum.lsu.edu/~Remsen/SACCBaseline.html). For other species, we follow BirdLife International (www.birdlife.org/datazone/species/).

Tony Martin



77. Part of the St Andrews Bay King Penguin colony showing adults incubating eggs (foreground) with young at the 'teddy bear' stage gathering in the background.

shown in table 1. Species that have bred only occasionally, non-breeding visitors and vagrants are covered in the next section.

There are two species of waterfowl resident on South Georgia. The South Georgia (Yellow-billed) Pintail (plate 76) is found almost anywhere where there are coastal pools surrounded by vegetation. It is an endemic subspecies (*A. g. georgica*) (previously, and perhaps correctly, considered as a full species). South Georgia Pintails are gregarious and groups of up to 80 may be found on favoured pools in summer; larger groups may form on the coast in winter when many pools freeze up. They feed mainly in streams and the intertidal zone, though they may scavenge on seal carcasses. Based on counts made during the 2005/06 and 2006/07 surveys, together with mark/recapture work in Cumberland Bay, the total breeding population is estimated to be around 6,000 pairs.

The Yellow-billed (Speckled) Teal *Anas flavirostris* was first discovered on South Georgia in 1971, when 40–50 were counted at various locations in Cumberland East Bay

(Weller & Howard 1972). Despite extensive searching, none were seen elsewhere in that season. Since then this species has been encountered in small numbers in other coastal locations around South Georgia, though it is nowhere common and the present breeding population is probably less than 20 pairs. The origin of this population is unknown: Weller & Howard (1972) speculated that a small population may have been introduced to the Cumberland East Bay area by whalers, but it is now believed that the South Georgia population is maintained by

immigration from South America (Prince & Croxall 1983).

At some locations, the habitat for both of these species has been affected by increasing numbers of Antarctic Fur Seals, and the resultant eutrophication of coastal pools and destruction of the tussock at low elevation. To what extent this has affected the population of the two duck species is unknown.

Four species of penguin breed regularly on South Georgia. The King Penguin is one of the island's iconic species, with large and spectacular colonies at several sites. From a population estimated to be only a few thousand pairs in the nineteenth century, this species is now doing well on South Georgia, as on other subantarctic islands. It is often assumed that the previously low population reflected widespread exploitation, but evidence for that on South Georgia is hard to obtain. The population is increasing and new colonies have been founded recently. The largest colonies are at St Andrews Bay (150,000 pairs), Salisbury Plain in the Bay of Isles (60,000 pairs), Royal Bay (30,000 pairs)

and Gold Harbour (25,000 pairs). The South Georgia population now almost certainly exceeds the previous estimate of 450,000 pairs (Poncet & Crosbie 2005).

The King Penguin has an unusual breeding cycle. A single egg is laid, and chick rearing takes 14–16 months. As a consequence, a pair breeding successfully in one year will follow this with a later breeding cycle in the next, and then skip a year before starting another early season breeding cycle, i.e. a successful pair will breed in two years out of three. Consequently, visitors to a colony will be met with both very young chicks, perhaps still being brooded, and older chicks that have gathered in a crèche and may even be moulting into adult plumage (plate 77).

The Gentoo Penguin *Pygoscelis papua* is common on South Georgia, with small colonies all around the coast and an estimated total population of 105,000 pairs (Trathan *et al.* 1996). Colonies can be up to several hundred metres inland, and the birds may shift the location of the colony by hundreds of metres between years. The Gentoo Penguin is heavily dependent upon Antarctic Krill for successful breeding. Changes in oceanographic and sea-ice conditions along the western Antarctic Peninsula, where krill

spawn, and in the wider Scotia Sea influence the availability of krill for the seabirds and marine mammals of South Georgia. In years of good krill availability, Gentoos may raise two chicks; when krill is less abundant, they may raise only one chick, or in extreme cases (once or twice a decade) may fail entirely.

South Georgia is the centre of the world population of the Macaroni Penguin *Eudyptes chrysolophus*, which breeds locally all around the coast on steep rock or tussac slopes. The largest colonies are on the north coast, notably on Bird Island and the Willis Islands. The South Georgia population may have been as large as 2.7 million pairs in the late 1970s (Prince & Croxall 1983). The population had been reduced by half in the 1990s and may now number fewer than one million pairs (Trathan *et al.* in press). The cause of this decline is unclear; it may result from competition for food with the rapidly expanding population of Antarctic Fur Seals and/or oceanographic changes leading to a reduction in the supply of Antarctic Krill.

The fourth species of penguin on South Georgia is the Chinstrap Penguin *P. antarcticus*. South Georgia is at the northern edge of this species' range, and the few colonies are all on the (colder) southern or



Tony Martin

78. Perhaps the iconic species of South Georgia, Wandering Albatross *Diomedea exulans*, displaying on Bird Island, South Georgia.

southeastern coasts; the South Georgia population is estimated at 12,000 pairs.

The other group of iconic South Georgia birds are the albatrosses, of which four species breed. The Wandering Albatross *Diomedea exulans* (plate 78) is the largest seabird in the South Georgia region, and the only great albatross (*Diomedea* sp.) breeding there. It is seen commonly following ships, and watching one of these birds in a strong wind is one of the great sights in birding. Breeding is confined to about 25 locations in the northwest of South Georgia, Annenkov Island, and a handful of sites in the southeast. The species has a circumpolar breeding distribution with large populations at three other island groups besides South Georgia (Îles Crozet, Îles Kerguelen and Prince Edward Islands) and a very small population on Macquarie Island. It ranges over huge distances during the non-breeding season, and both adults and immature birds can be found all over the Southern Ocean and as far north as 25°S. Chick rearing takes about nine months, and successful pairs will thus breed biennially. The population at Bird Island has been monitored continuously for over 35 years, and with intermittent population data prior to this and annual censuses of the Bay of Isles populations since 1999, there is a clear picture of population trends.

The South Georgia population was estimated to be 4,283 pairs in 1979 (Croxall 1979) but only 1,553 pairs in 2003/04 (Poncet *et al.* 2006). This population is now known to be declining rapidly, at a rate of about 4% per annum since the late 1990s, caused principally by incidental mortality in longline fisheries.

The beautiful and charismatic Light-mantled Albatross *Phoebastria palpebrata* (plate 79) breeds along much of the coast of South Georgia in isolated pairs and small loose breeding groups on steep tussac slopes and cliff ledges that allow easy access. It is fairly common at sea all around the island, and has an engaging habit of riding the updraft alongside the superstructure of ships, affording opportunities for close views. During the breeding season, pairs of birds perform tandem aerial displays, gliding to and fro along the nesting cliffs. Breeding birds can be encountered far inland, away from most other wildlife on South Georgia; on calm days their characteristic mournful call might be the only sound audible, and is one of the most evocative wildlife experiences that South Georgia has to offer. Adults undertake longer foraging trips and feed farther south during chick rearing than do other albatrosses on South Georgia, travelling to the southern edge of the Scotia Sea and even into the marginal



Tony Martin

79. Light-mantled Albatross *Phoebastria palpebrata* on the nest.

ice zone of the Weddell Sea. The scattered nature of the breeding population makes this a difficult species to survey. There has never been a comprehensive survey, and the only population estimate, based on extrapolation from the number of nests recorded on a 60-km stretch of coastline in 1976, is 5,000 pairs. During the last decade, a small monitoring area on Bird Island suggested that the population is broadly stable, although the numbers breeding vary greatly from year to year. Non-breeders from the South Georgia population remain predominantly in polar and subpolar waters of the South Atlantic.

Two species of smaller albatross, traditionally referred to by the old sailor's term 'mollymawk', breed on South Georgia. The Grey-headed Albatross *Thalas-sarche chrysostoma* breeds in nine areas of the northwest, with the largest colonies on Bird Island, the Willis Islands and Paryadin Peninsula. Breeding adults feed in the Antarctic Frontal Zone and as far south as the southern boundary of the Scotia Sea. The breeding cycle is long, and successful pairs nest biennially. After breeding, some birds stay in the southwest Atlantic, some travel as far as the southwest Indian Ocean and some undertake one or two complete circumpolar migrations before returning to South Georgia to nest (Croxall *et al.* 2005). The most recent complete population census, in 2003/04, revealed

47,670 breeding pairs (Poncet *et al.* 2006). This species has a local but circumpolar breeding distribution at subantarctic islands, and at Diego Ramirez Islands, in southern Chile. South Georgia supports 40% of the world population, however, and monitoring studies at Bird Island have revealed a decline of >2% per annum (Poncet *et al.* 2006). Grey-headed Albatrosses are much less frequently reported as bycatch in longline fisheries than many other albatrosses, so this decline may partly reflect a long-term shift in food availability.

The Black-browed Albatross *T. melano-phris* breeds more widely on South Georgia than does the Grey-headed, with colonies in



Tony Martin

80. Southern Giant Petrel *Macronectes giganteus*. Males of this species are major scavengers of seal carcasses, whereas females feed at sea.



Andrew Clarke

81. Snow Petrel *Pagodroma nivea* on its nest under a boulder, high on Mt Hodges, South Georgia.



James Lidster

82. Blue Petrel *Halobaena caerulea*. This species was first found on mainland South Georgia in 1971, but is now known to breed widely across the island. It is also regularly seen at sea and ventures far south into the cold waters of the marginal ice zone.



James Lidster

83. Antarctic Prion *Pachyptila desolata*. South Georgia is the global stronghold for this species, with a breeding population estimated at 22 million pairs.

about 15 locations in the northwest, but also in the southeast at Annenkov, Cooper and Green Islands. The most recent census suggested a breeding population of 74,290 pairs in 2003/04 (Poncet *et al.* 2006). Monitoring work on Bird Island has revealed a sharp decline of about 3–4% per annum, resulting mainly from incidental mortality in longline

and trawl fisheries. During the non-breeding period most South Georgia birds migrate to the Benguela Current upwelling off southwest Africa, although some move to the Patagonian Shelf and others to Australasia. It is during this non-breeding period that the birds are most critically exposed to incidental mortality from fisheries operations. The species has a circumpolar breeding distribution, and South Georgia supports around 12% of the world population.

The Southern Giant Petrel *Macronectes giganteus* (plate 80) nests in small, widely scattered, loose colonies all around South Georgia. The Northern Giant Petrel *M. halli* breeds earlier than *giganteus*, with the entire breeding cycle about six weeks ahead. In both species the males forage on beaches, typically taking carrion from seal colonies, whereas the females forage widely at sea. The best estimate of the South Georgia populations, based on recent fieldwork, is c. 8,700 pairs of *giganteus* and c. 17,200 pairs of *halli* (Poncet *et al.* unpubl. data). Where they encounter humans, these species are particularly sensitive to disturbance

during the breeding cycle. Although both have circumpolar breeding distributions, *halli* has a smaller global population than *giganteus*, and almost half the world population is found on South Georgia.

The appearance of the attractive and very distinctive Cape Petrel *Daption capense* in the wake is often the first sign that a ship is

approaching the Southern Ocean. Cape Petrels are common at sea around South Georgia, and c. 10,000 pairs nest on ledges and in crevices at scattered sites all around the island. The Snow Petrel *Pagodroma nivea* (plate 81) is at the northern limit of its breeding range on South Georgia, where it tends to nest in inaccessible crevices high in mountains. This makes it difficult to census and the best estimate of the South Georgia population is c. 3,000 pairs (Prince & Croxall 1983). It is seen reasonably commonly at sea around the island, especially when pack-ice is present.

Although long-known from the waters all around South Georgia, where it is seen commonly, the Blue Petrel *Halobaena caerulea* (plate 82) was not found on land until 1971. Soon afterwards, breeding sites were located in tussac slopes on Bird Island, and it is now known to breed widely on the south coast and offshore islands, where rats are absent. The South Georgia population was estimated at 70,000 pairs by Prince & Croxall (1983). Blue Petrels breed on most subantarctic islands, and also in southern Chile.

Two species of prion breed on South Georgia. The Antarctic Prion *Pachyptila deso-*

lata (plate 83) is abundant, and huge numbers can be seen in flight or in rafts on the sea near colonies in the evening. It breeds in a wide range of habitats including tussac, *Festuca* grassland, fellfield and boulder scree. The South Georgia population was estimated at 22 million pairs in the 1980s, out of a total world population of 25 million pairs. The Fairy Prion *Pachyptila turtur* nests locally in rock crevices on boulder beaches, and can often be seen at sea close to shore in the daytime, when Antarctic Prions are usually farther offshore. The South Georgia population is small, perhaps 1,000 pairs (British Antarctic Survey unpubl. data), but it is a very common breeder on subtropical and subantarctic islands in the Indian and Pacific Oceans.

The White-chinned Petrel is a conspicuous species, seen commonly at sea around South Georgia and with a marked propensity to follow ships. It nests extensively in tussac grass and on offshore islands. The South Georgia population was originally estimated at around two million pairs (Prince & Croxall 1983), but a substantial (c. 30%) decline had occurred on Bird Island by the late 1990s (Berrow *et al.* 2000) and measurements of breeding density from surveys in 2005/06



Tony Martin

84. Wilson's Storm-petrel *Oceanites oceanicus*, feeding close to shore among fronds of kelp *Macrocystis pyrifera*.

and 2006/07, coupled with an estimate of the total area of suitable habitat, suggested a total of 670,000 occupied nests and a total breeding population of 900,000 pairs (Martin et al. 2009). This species suffers extensively from incidental mortality in fisheries, and its breeding habitat may also have been reduced and/or degraded by trampling from the increasing population of Antarctic Fur Seals; data from Bird Island suggest that this species continues to decline at around 2% per annum.

Three storm-petrels nest on South Georgia, of which the commonest by far is Wilson's Storm-petrel *Oceanites oceanicus* (plate 84). This small petrel breeds abundantly on the island, mostly in rocky scree crevices but also in moss banks and adjacent areas of sparse vegetation. The South Georgia population was estimated at 600,000 pairs by Prince & Croxall (1983); there have been no recent surveys but the population is clearly substantial. The small and dainty Grey-backed Storm-petrel *Garrodia nereis* is seen only infrequently at sea around South Georgia, and is most often encountered feeding around patches of floating kelp *Macrocystis pyrifera*. Very few breeding records exist and the population is unlikely to exceed a hundred pairs. The Black-bellied Storm-petrel *Fregetta tropica* is encountered far less frequently than Wilson's Storm-petrel at sea around South Georgia. It is a rare breeder on Bird Island and has been recorded breeding at only a few other mainland sites. Despite the widespread availability of appar-

ently suitable breeding habitat (mainly on steep tussac slopes), the total South Georgia population probably numbers fewer than 10,000 pairs (Prince & Croxall 1983).

Two diving petrels breed on South Georgia. Both are common, and both can be seen in large numbers offshore from colonies in the evening; and they are extremely difficult to distinguish at sea. The South Georgia Diving Petrel *Pelecanoides georgicus* nests in long burrows dug into fine scree, and hence often at considerable altitude. Based on crude extrapolations from detailed surveys on Bird Island, the South Georgia population was estimated at two million pairs (Croxall & Hunter 1982). The species breeds on Annenkov Island at similar densities to those on Bird Island. Both of these islands are rat-free, but elsewhere most colonies are small and in rat-infested areas, and so the total population may be less than the extrapolated figure. The Common Diving Petrel *P. urinatrix* is also a common breeder, nesting in steep tussac slopes rather than scree. The South Georgia population has been estimated at 3.8 million pairs (Prince & Croxall 1983), about half the estimated global population.

The Imperial Shag *Phalacrocorax atriceps* is the only species of cormorant recorded from South Georgia, and it is widely distributed around the island. It nests among tussac clumps on cliff faces or on steep slopes overlooking the sea. It is restricted to inshore waters, where it can often be seen fishing cooperatively in large rafts. The South Georgia

population is estimated at 10,300 pairs (Poncet & Crosbie 2005). The taxonomy of the Southern Ocean shags remains controversial and unresolved. The IOC (Gill & Wright 2006) gave species status to the South Georgia shag (as *Leucocarbo georgicus*) but BirdLife (and others) are reverting to the



John Loines

85. Two Antarctic Terns *Sterna vittata*.

earlier treatment until the taxonomic status of the numerous allopatric taxa in this group is clarified.

The Snowy Sheathbill *Chionis albus* is an ubiquitous attendee at seal beaches and penguin colonies. It breeds in small numbers all around South Georgia, and its population is estimated at 2,000 pairs. Elsewhere, it breeds south to 65°S on the Antarctic Peninsula, and many winter in the Falkland Islands and southern South America.

The Kelp Gull *Larus dominicanus*, the only gull breeding on South Georgia, where the population is estimated to be 2,000 pairs, is found sparsely all around the coasts. The diet is predominantly marine invertebrates, particularly the intertidal limpet *Nacella concinna*, and in some areas substantial middens of limpet shells have accumulated. Like all gulls, this species is highly adaptable and will take carrion, refuse and fishery waste when available. The only breeding tern is the Antarctic Tern *Sterna vittata* (plate 85), which nests in small colonies all along the coast, and sometimes far inland; its population is estimated at 2,500 pairs. The Brown Skua *Stercorarius antarcticus* is common at sea and breeds widely on South Georgia, although densities tend to be higher on offshore islands, possibly because chicks are predated by rats elsewhere. By far the largest breeding concentration is on Bird Island (470 pairs), probably reflecting the food supply from the high population of Antarctic Fur Seals there. The total South Georgia population is estimated to be 1,000–2,000 pairs.

The South Georgia Pipit (plate 86) is the only breeding passerine, and is endemic. Since it nests on or near the ground in tussac clumps, the eggs and young suffer heavy predation from Brown

Rats, and the present breeding distribution is limited to about 20 rat-free offshore islands and some areas of the mainland southern coast that are isolated by glaciers from invasion by rats (fig. 4). Most birds winter along ice-free shorelines, and post-breeding dispersal may carry them into rat-infested areas. The population is believed to be around 3,000 pairs.

Rare and occasional breeders

In addition to the 29 species that breed regularly on South Georgia, three species have bred or attempted to breed. The Adélie Penguin *Pygoscelis adeliae* is mostly a very rare visitor to South Georgia; this is the most southerly of three pygoscelid penguins and its ecology is tied strongly to sea-ice. A single nest with eggs was reported in 1996, with a second pair attending an empty nest in the same year; while two pairs with nests (both empty) were found in 2006. With the current gradual shift southwards of the populations of all three pygoscelid penguins in response to climate change, Adélie Penguins will undoubtedly remain rare on South Georgia. Individual Southern Rockhopper Penguins *Eudyptes chrysocome* are recorded occasionally in Macaroni Penguin colonies. A few pairs bred in the 1980s but the species has reverted to the status of rare visitor, presumably associated with its widespread decline in



James Lidster

86. The endemic South Georgia Pipit *Anthus antarcticus* is the only breeding passerine on South Georgia.

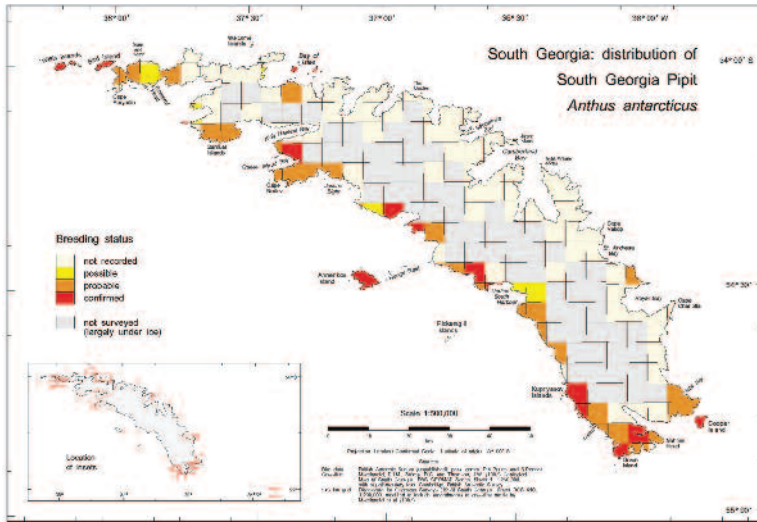


Fig. 4. Map showing the breeding distribution of the South Georgia Pipit, with breeding limited to areas free of Brown Rats (see fig. 3). Reproduced with permission from Trathan *et al.* (1996).

the Falklands and elsewhere. The White-capped Albatross *Thalassarche steadi* is generally a very rare visitor, presumably from the small population known to migrate regularly to temperate waters of the southwest Atlantic off Uruguay (Jiménez *et al.* 2009). However, a single male, first seen in 2002/03, has bred with a female Black-browed Albatross on Bird Island since 2007/08 and chicks were hatched in this and the following two seasons, one fledging successfully in 2009/10.

Non-breeding visitors and vagrants

Current knowledge of non-breeding visitors and vagrants to South Georgia is summarised in table 2. Most records of vagrants come from three main areas: Bird Island and King Edward Cove, where there is a year-round scientific presence, and from offshore waters visited by scientific and tourist vessels. From the early 1970s, a comprehensive database of vagrant and non-breeding birds on South Georgia was maintained at BAS, initially by Peter Prince, and this was kept going until the early 2000s. Table 2 includes those records known to the authors; although vagrants recorded ashore on South Georgia remain reasonably well documented, this is not the case for at-sea sightings and there will undoubtedly be many records from tourist and research vessels of which we are unaware.

The publication of the Antarctic Map

Folio for birds (Watson & Harper 1971) and the first Antarctic field guide (Watson 1975) were landmarks which enabled a realistic appraisal of the status of seabirds seen in South Georgia waters. From the 1970s, BAS oceanographic work provided opportunities for extended periods of observation at sea over the continental shelf waters around the island.

It was quickly established that Great Puffinus *gravis* and Sooty Shearwaters *P. griseus* were regular visitors to the area, including shelf waters. Both tend to be seen more frequently to the west of the island, notably in the area around Shag Rocks; Great Shearwaters breed to the north at Tristan da Cunha, and Sooty Shearwaters nest in large numbers in southern South America (with a few thousand pairs in the Falklands). In 1986 there was a notable influx of Great Shearwaters (and other less common species) to South Georgia waters, associated with a southerly movement of warm waters (Hunt *et al.* 1992), emphasising the powerful influence of oceanography on seabird distribution.

Slender-billed Prion *Pachyptila belcheri* also breeds in large numbers in the Falklands, and although a few corpses have been recorded on South Georgia, these have invariably related to skua predation, presumably of occasional visitors attending colonies of Antarctic Prions; there is still no evidence that the Slender-billed Prion breeds on South Georgia. This species has undoubtedly been overlooked around South Georgia because of the difficulty in separating it from Antarctic Prion at sea; while it is now clear that these species are largely separated ecologically by the Antarctic Polar Front, the finer details of distribution, migration and dispersal patterns remain unknown. Broad-billed Prion

Table 2. Occasional breeding species, visitors and vagrants to South Georgia. V: vagrant; OB: occasional breeder; NBV: regular but non-breeding visitor; SAV: ship-assisted vagrant; I: introduced and subsequently extirpated. For vagrants, the number of confirmed occurrences known to the authors, followed by the estimated number of individual birds involved where known, are shown in brackets; nd: data not known to authors. These totals include all records listed by Prince & Croxall (1996). Note that anecdotal records of Manx Shearwater *Puffinus puffinus*, Mottled Petrel *Pterodroma inexpectata*, White-bellied Storm-petrel *Fregetta grallaria*, Red Knot *Calidris canuta*, and Brown-hooded Gull *Larus maculipennis* have not been listed as we have insufficient knowledge of date, location or observer. Additionally, previously published records of Olrog's Gull *Larus atlanticus* and House Martin *Delichon urbicum* are not included as their identification is now regarded as not confirmed.

Species	Scientific name	Status
Black-necked Swan	<i>Cygnus melanocoryphus</i>	V (1,1)
Upland Goose	<i>Chloephaga picta</i>	I
Chiloe Wigeon	<i>Anas sibilatrix</i>	V (6,8)
Blue-winged Teal	<i>Anas discors</i>	V (1,1)
Emperor Penguin	<i>Aptenodytes forsteri</i>	V (9,9)
Adélie Penguin	<i>Pygoscelis adeliae</i>	V/OB (19,20)
Southern Rockhopper Penguin	<i>Eudyptes chrysocome</i>	V/OB
Royal Penguin	<i>Eudyptes schlegeli</i>	V (5,6)
Magellanic Penguin	<i>Spheniscus magellanicus</i>	V (8,9)
Southern Royal Albatross	<i>Diomedea epomophora</i>	NBV
Northern Royal Albatross	<i>Diomedea sanfordi</i>	V (nd)
Antipodean Albatross	<i>Diomedea antipodensis</i>	V (1,1)
Sooty Albatross	<i>Phoebastria fusca</i>	V (7,7)
White-capped Albatross	<i>Thalassarche steadi</i>	V/OB (11, 4)
Salvin's Albatross	<i>Thalassarche salvini</i>	V (2,1)
Antarctic Fulmar	<i>Fulmarus glacialisoides</i>	NBV
Antarctic Petrel	<i>Thalassoica antarctica</i>	NBV
Broad-billed Prion	<i>Pachyptila vittata</i>	V (3,4)
Slender-billed Prion ¹	<i>Pachyptila belcheri</i>	NBV
Kerguelen Petrel	<i>Aphrodroma brevirostris</i>	NBV
Great-winged Petrel	<i>Pterodroma macroptera</i>	V (3,3)
White-headed Petrel	<i>Pterodroma lessonii</i>	V (5,5)
Atlantic Petrel	<i>Pterodroma incerta</i>	V (9,13)
Soft-plumaged Petrel	<i>Pterodroma mollis</i>	NBV
Grey Petrel	<i>Procellaria cinerea</i>	NBV
Little Shearwater ²	<i>Puffinus elegans</i>	V (2,2)
Sooty Shearwater	<i>Puffinus griseus</i>	NBV
Great Shearwater	<i>Puffinus gravis</i>	NBV
Cattle Egret	<i>Bubulcus ibis</i>	V (>45, >300)
Cocoi Heron	<i>Ardea cocoi</i>	V (2,2)
Great Egret	<i>Ardea alba</i>	V (4,4)
Snowy Egret	<i>Egretta thula</i>	V (3,3)
Turkey Vulture	<i>Cathartes aura</i>	V (17,8)
Peregrine Falcon	<i>Falco peregrinus</i>	V (4,4)
Allen's Gallinule	<i>Porphyrio alleni</i>	V (1,1)
Purple Gallinule	<i>Porphyrio martinicus</i>	V (1,1)
Rufous-chested Plover	<i>Charadrius modestus</i>	V (1,1)
Solitary Sandpiper	<i>Tringa solitaria</i>	V (2,2)
Spotted Sandpiper	<i>Actitis macularius</i>	V (1,1)
Little Stint	<i>Calidris minuta</i>	V (1,1)
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	V (22,23)
Baird's Sandpiper	<i>Calidris bairdii</i>	V (1,1)
Pectoral Sandpiper	<i>Calidris melanotos</i>	V (7,7)
Wilson's Phalarope	<i>Phalaropus tricolor</i>	V (2,2)
Dolphin Gull	<i>Leucophaeus scoresbii</i>	V (4,6)

¹ Also widely known as Thin-billed Prion.

² This is the form increasingly known as Subantarctic Little Shearwater *Puffinus (assimilis) elegans*.

Table 2. Occasional breeding species, visitors and vagrants to South Georgia. *continued*

Franklin's Gull	<i>Leucophaeus pipixcan</i>	V (2,2)
Arctic Tern	<i>Sterna paradisaea</i>	V (3,5)
South Polar Skua	<i>Stercorarius maccormicki</i>	V (1,1)
Long-tailed Skua	<i>Stercorarius longicaudus</i>	V (1,1)
Eared Dove	<i>Zenaida auriculata</i>	SAV (1,1)
Barn Owl	<i>Tyto alba</i>	V (1,1)
Dark-faced Ground-tyrant	<i>Muscisaxicola maclovianus</i>	V (1,1)
Eastern Kingbird	<i>Tyrannus tyrannus</i>	V (1,1)
Grey-flanked Cinclodes	<i>Cinclodes oustaleti</i>	V (1,1)
Chilean Swallow	<i>Tachycineta leucopyga</i>	V (4,5)
Barn Swallow	<i>Hirundo rustica</i>	V (8,8)
Long-tailed Meadowlark	<i>Sturnella loyca</i>	V (1,1)
House Sparrow	<i>Passer domesticus</i>	SAV (1,1)

P. vittata breeds on Tristan da Cunha but appears to be only a very rare visitor to South Georgia, particularly in years when warmer waters extend southwards. Two other seabirds are far more regular visitors to South Georgia than had been recognised before the 1970s: Kerguelen Petrel *Aphrodroma brevirostris* (plate 87) and Soft-plumaged Petrel *Pterodroma mollis*. The final seabird which is now recognised as a regular non-breeding visitor is Southern Royal Albatross *Diomedea epomophora*. This is seldom seen in coastal or shelf waters, but is regularly identified over deeper offshore waters.

The remaining seabirds listed in table 2 are known from only a few records and are best considered as vagrants. There are very

few confirmed records of Arctic Tern *Sterna paradisaea*, but this species winters in numbers in the Weddell Sea, and so would be expected to pass through South Georgia regularly on migration.

Eight wader species have occurred as vagrants on South Georgia, largely those that would be expected based on their migratory patterns but to our knowledge Little Stint *Calidris minuta* remains the only formal record for South America. Other non-passerines include three species of waterfowl, four herons, two gallinules, two raptors, one pigeon and one owl (table 2). Of these, Cattle Egrets *Bubulcus ibis* have turned up sufficiently frequently for the species to be classed as a regular visitor. Since the first record, in

1977, Prince & Croxall (1996) documented a total of 191 birds, with marked arrivals in 1978, 1980, 1988 and 1989. No fewer than 26 came aboard the US research vessel *Nathaniel B. Palmer* halfway between the Falklands and South Georgia, and disembarked at Stromness whaling station in May 1993 (Prince & Croxall 1996). Since then, single birds and the occasional party (one of 22 birds) have been recorded in most years.



Morten Jørgensen

87. Kerguelen Petrel *Aphrodroma brevirostris*. This species is a regular visitor to shelf waters around South Georgia, but does not breed there.

Cattle Egrets have occurred elsewhere in Antarctica, as far south as the Argentine Islands off the west coast of the Antarctic Peninsula at 65°S. Recently, sightings have been fewer, although they are still recorded in most years.

Passerine vagrants are few and only Chilean Swallow *Tachycineta leucopyga* and Barn Swallow *Hirundo rustica* have occurred more than once. Dark-faced Ground-tyrant *Muscisaxicola maclovianus* and Long-tailed Meadowlark *Sturnella loyca* are both widespread in South America and breed in the Falklands, while Grey-flanked Cinclodes *Cinclodes oustaleti* is found in southern South America and Eastern Kingbird *Tyrannus tyrannus* winters south to Argentina.

The South Georgia avifauna thus totals 87 species, of which 29 are regular breeders, three are occasional breeders, nine (all seabirds) are regular non-breeding visitors, 45 are vagrants (two of which were ship-assisted) and one species was introduced but is now extinct on the island. Species for which we have anecdotal knowledge of sightings since 1995 in or near to the South Georgia area, but insufficient information on date, location or observer, include Manx Shearwater *Puffinus puffinus*, Mottled Petrel *Pterodroma inexpectata*, White-bellied Storm-petrel *Fregetta grallaria*, Red Knot *Calidris canutus* and Brown-hooded Gull *Larus brunnicapillus*.

Potential future records

The many changes in status and additions to the South Georgia avifauna evident from Prince & Payne (1979), Prince & Croxall (1983, 1996) and this paper, coupled with rapidly increasing knowledge of field characters of seabirds and significantly greater observer coverage, suggest that new species will continue to be added to the South Georgia list. Increased observation will probably show that some species known only as vagrants or rare visitors are actually regular in small numbers. These could include Northern Royal Albatross *Diomedea sanfordi*, White-headed Petrel *Pterodroma lessoni*, Great-winged Petrel *P. macroptera*, Atlantic Petrel *P. incerta*, Broad-billed Prion and Little Shearwater *Puffinus elegans*. Seabirds that might be expected to occur occasionally

include Manx Shearwater, Mottled Petrel, White-bellied and Leach's Storm-petrels *Oceanodroma leucorhoa*. It is also conceivable that oceanographic conditions bringing warmer water south, coupled with a strong northerly airstream, might also bring species common in temperate and subtropical waters of the South Atlantic, such as Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*, Spectacled Petrel *Procellaria conspicillata*, Trindade Petrel *Pterodroma arminjoniana*, Cory's Shearwater *Calonectris diomedea* and White-faced Storm-petrel *Pelagodroma marina* into South Georgia waters. At present there are no records of any other taxon in the Wandering Albatross complex (e.g. Tristan Albatross *Diomedea dabbenena*) from South Georgia waters, although recently a single (ringed) Antipodean Albatross *D. antipodensis* was found on Bird Island. Tristan Albatross is widespread (but rare) in temperate waters well to the north and the Antipodean Albatross occurs regularly on migration off the coast of southern Chile; both might occur in South Georgia waters but will be challenging to identify at sea.

Both Pomarine *Stercorarius pomarinus* and Arctic Skuas *S. parasiticus* have been seen at latitudes farther south than South Georgia, while Sabine's Gulls *Xema sabini*, which winter in the Benguela Current and are seen commonly off southern South Africa, might wander to South Georgia occasionally. A number of other shorebirds with long migration routes that carry them to southern South America may overshoot to South Georgia; these include Grey Phalarope *Phalaropus fulicarius*, Upland Sandpiper *Bartramia longicauda* and Least Sandpiper *Calidris minutilla*. It is also possible that South American Snipe *Gallinago paraguayiae* might wander to South Georgia from the Falklands or southern Patagonia. Passerines are less easy to predict, but possibilities include Purple Martin *Progne subis*, White-crested Elaenia *Elaenia albiceps*, Patagonian (Rufous-backed) Negrito *Lessonia rufa*, and Rufous-collared Sparrow *Zonotrichia capensis*. But experience elsewhere suggests that the safest prediction would be that one of the next species to be added to the South Georgia list will not have been predicted.

The importance of South Georgia

In terms of seabird abundance, and especially biomass, South Georgia is without doubt one of the world's most important seabird islands. Even today, with petrel populations perhaps an order of magnitude lower than before the introduction of rats, it is estimated that over 100 million individual seabirds are based there. South Georgia is the world's most important breeding site for six species (Macaroni Penguin, Grey-headed Albatross, Northern Giant Petrel, Antarctic Prion, White-chinned Petrel, Common Diving Petrel) and is probably in the top three such sites for seven others (King Penguin, Gentoo Penguin, Wandering Albatross, Black-browed Albatross, Southern Giant Petrel, Black-bellied Storm-petrel, South Georgia Diving Petrel). Several of these species are also Globally Threatened or Near Threatened (see table 1), which underlines the importance of South Georgia and of actions to improve the conservation status of its species. Although South Georgia is currently classified by BirdLife International (see Poncet 2006) as a single Important Bird Area (IBA), closer scrutiny may well reveal that it is better

viewed as comprising several distinct IBAs. In addition, if the South Georgia subspecies of the Yellow-billed Pintail was reinstated at species rank, then South Georgia would, under the BirdLife classification, become a full Endemic Bird Area, rather than a secondary area as at present (Stattersfield *et al.* 1998).

Present threats to South Georgia breeding birds

The populations of breeding birds on South Georgia are threatened both on land and at sea. On land, the most important factors governing the distribution and abundance of breeding seabirds are the presence of introduced Brown Rats and Reindeer, and the impact of the expanding population of Antarctic Fur Seals.

Brown Rats have had a major effect on the South Georgia avifauna. Rats were introduced accidentally by the early whalers and sealers, possibly as long ago as the eighteenth century, and now occupy the entire northeast coast of the island, and the northwestern portion of the south coast. Their most significant impact has been on the endemic South



Ewan Edwards

88. Where Tussac Grass *Poa flabellata* is accessible to Antarctic Fur Seals *Arctocephalus gazella*, the habitat is extensively degraded, and no longer supports nesting birds. The rapid expansion of the seal population following collapse of the sealing industry has significantly reduced the area of nesting habitat for seabirds on South Georgia.

Georgia Pipit, which has been completely eliminated in all areas with rats. However, the presence of rats also has a major impact on some burrow-nesting seabirds, with some smaller species being absent entirely in areas with rats. In addition to Brown Rats, House Mice are known from a few areas of South Georgia. In areas where mice are present, populations of South Georgia Pipit are significantly reduced.

Where Reindeer are present, their grazing has modified the natural vegetation extensively. In particular, they have reduced the coverage of Tussac Grass, thereby eliminating important breeding habitat for many burrow-nesting species, and have collapsed existing burrows by trampling. However, areas with Reindeer also contain Brown Rats, and while these areas have greatly reduced numbers of burrow-nesting seabirds it is not easy to separate the relative impact of these two introduced mammals.

The expansion of the Antarctic Fur Seal population also affects the habitat for breeding seabirds. The most severe impacts are the destruction of tussac grassland (plate 88) and a shift in the vegetation, with replacement of Antarctic Hair-grass *Deschampsia antarctica* by the introduced Annual Meadow-grass, which is more tolerant of trampling and enhanced nutrient input. In northwest South Georgia (the source of Antarctic Fur Seal population recovery and expansion), much of the low-altitude grassland has been effectively destroyed as a breeding habitat for seabirds, as well as for South Georgia Pipits and South Georgia Pintails, thus restricting many species to sites inaccessible to the seals. The extent to which such displacement has been accompanied by local population decline is uncertain.

In the marine environment, widespread and traditional threats such as oil pollution, toxic effects of chemical residues and ingestion of plastics are generally uncommon, even rare, among South Georgia seabirds, though more problematic for those species which move to South American coastal waters in winter or are transequatorial migrants. The main threats to seabirds at sea come from interactions with commercial longline and trawl fisheries. A substantial mortality of albatrosses as bycatch in long-

line fisheries, and its major role in their population declines, was discovered in the early 1990s. It was then recognised also to involve giant petrels, and especially White-chinned Petrels, for which population trend data were scarce or absent. In 1997, bycatch estimates were produced, indicating that around 6,000 albatrosses and petrels were being killed annually around South Georgia and that longline fishing was the likely main cause of the declines in the island's Wandering, Black-browed and Grey-headed Albatross populations. Decisive action for the compulsory use of a suite of technical and operational measures to address this problem was taken from 1998 onwards by CCAMLR, the body responsible for the management of Southern Ocean fisheries, including those around South Georgia. With the wholehearted support of the Government of South Georgia and the South Sandwich Islands, and the UK, these actions reduced the problem to negligible proportions locally over the next five years (Croxall 2008). Similar problems, but at a smaller scale, were also evident in seabird mortality associated with trawl fisheries and these were also tackled effectively in the fisheries around South Georgia.

Unfortunately, bycatch of South Georgia seabirds in longline and trawl fisheries is still widespread and substantial in many areas outside South Georgia waters. This affects juveniles and immatures throughout the year and adults outside the breeding season. For South Georgia birds the most serious problems are in the waters of, and adjacent to, northern Argentina, Uruguay and southern Brazil; there are also severe problems in the Benguela and Humboldt Currents and in the southern Indian Ocean for some species. Despite the creation of an international convention, the Agreement on the Conservation of Albatrosses and Petrels (ACAP), to address these (and all other) threats to albatrosses, giant petrels and *Procellaria* petrels and the increasingly effective activities of the BirdLife Albatross Task Force in the Benguela Current system and in the southwest Atlantic, South Georgia albatrosses and large petrels are still being killed at levels that are unsustainable. Most species continue to decline at rates of between 1% and 4% per annum.

Mitigation: eradication of rodents

A phased eradication of introduced rodents on South Georgia began in March 2011, with the aerial spreading of rodenticide-laced cereal bait over 128 km² of the central north coast. This project is financed and run by the South Georgia Heritage Trust, and it is expected that two further seasons of bait spreading will be required before the entire island can be declared rodent-free. South Georgia is many times larger than any island hitherto targeted for rodent eradication, but its larger glaciers are barriers to rodent movement and effectively divide the island into many separate but contiguous baiting zones, each of which can be treated independently.

The return of birds to breed in areas from which their ancestors were displaced decades or centuries ago is expected to commence in some species soon after rodents have been removed. However, most of the seabird species affected demonstrate high natal philopatry, so range expansion will be slow and it may be centuries before a new steady state is achieved. At that time the abundance of species especially vulnerable to rat predation, such as storm-petrels, Blue Petrels and South Georgia Pipits, may be one or two orders of magnitude greater than now.

Past and present climate change

In common with all of Antarctica, South Georgia is recovering from the last glacial maximum, when it was covered in glaciers that extended to the edge of the present continental shelf. Although the presence of small refugia cannot be discounted, we must assume that the bulk of the present flora and fauna has colonised in the past 17,000 years or so. In geological and evolutionary terms, the present seabird fauna represents a relatively recent colonisation. The growth and decay of continental ice sheets in cycles of 40,000 and 100,000 years, driven by changes in the earth's orbit (Milankovitch climate cycles), will thus have exposed and removed breeding habitat for seabirds on a regular basis, and also shifted feeding grounds as the oceanography changed.

At present, most of the glaciers on South Georgia are retreating as the climate warms (Gordon *et al.* 2008). While altitudinal shifts

in breeding distribution are possible as vegetation zones move higher, the major influence of current climate change is to allow the further spread of introduced Reindeer and Brown Rats out of areas that were previously delimited by impassable glaciers and the sea. This leads to the probability that, in the absence of rat eradication measures, seabirds currently isolated from such threats will become exposed, with consequent declines in population and breeding success.

The warming climate is also having more subtle effects, including reduced winter snowfall and summers that are becoming longer, and perhaps wetter. The data are currently anecdotal but there are indications that climate change is increasing the breeding potential of both Reindeer and Brown Rats, and also of South Georgia Pipits. In the last case, longer summers allow for longer and more productive breeding seasons, with dispersing juveniles being seen more widely than previously.

It seems probable that the species most vulnerable to ongoing climate change are those whose ecology is intimately associated with sea-ice. It is quite possible that Snow Petrels and Chinstrap Penguins may eventually not breed at all on South Georgia. Those species with specialised habits closely adapted to current South Georgia conditions are also likely to be affected, and both Gentoo Penguins and Imperial Shags may decline. For species dependent on the proximity of feeding areas such as the Antarctic Polar Front, which may move farther from South Georgia, more demanding foraging may lead to the population decline of, for example, Macaroni Penguins, King Penguins, and Grey-headed Albatrosses. If oceanographic conditions cause a substantial change in krill availability around South Georgia, that could promote large-scale changes in the abundance and composition of the marine avifauna.

The future: tourism and conservation

Some 6,000–7,000 people visit South Georgia each year. The majority are recreational visitors on cruise ships but other visitors include yacht crews and contract workers, researchers, military personnel and passen-

gers on a variety of vessels associated with resupply, research, fishing and military activities. Ship-based tourist activities include shore landings and Zodiac cruising, with occasional sub-aqua diving, camping, mountaineering and kayaking excursions. The only land-based tourism facility on the island is the South Georgia Museum at Grytviken. There are no accommodation facilities for tourists on the island, although those on climbing and scientific expeditions are permitted to camp, and both day and longer-term visitors occasionally occupy the field huts on the central north coast. Current legislation requires all expeditions and any visitors wishing to stay overnight on South Georgia away from King Edward Point to obtain Government permits.

It is unlikely that the tightly regulated tourism will have any significant negative impacts on the environment or wildlife of South Georgia. Indeed, the burgeoning awareness of South Georgia and the problems faced by its wildlife is likely to be beneficial in bringing increased pressure for all initiatives seeking to restore the wildlife to its former glories (before humans arrived); the ever greater number of visiting birders will also undoubtedly add to our knowledge of the island's birdlife.

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89. Peter Prince at Bird Island, South Georgia, where he undertook pioneering work on the feeding and reproductive biology of albatrosses. He also made the first scientific study of Blue Petrels *Halobaena caerulea* there, and both organised and led the first all-island survey of the breeding birds of South Georgia.