1997 Distribution and Abundance Survey

of Seabirds and Seals

at the South Sandwich Islands in the Scotia Sea

Report to
The Commissioner for South Georgia and the South Sandwich Islands
and
The Foreign and Commonwealth Office

from
Jerome Poncet
Beaver Island, Falkland Islands, South Atlantic
1997 Distribution and Abundance Survey

of Seabirds and Seals

at the South Sandwich Islands in the Scotia Sea

Report to

The Commissioner for South Georgia and the South Sandwich Islands

and

The Foreign and Commonwealth Office

from

Jerome Poncet

Beaver Island, Falkland Islands

Copyright 1997 Government of South Georgia and the South Sandwich Islands

Front Cover: survey vessel Damien II anchored off Beach Point at Thule Island, South Sandwich Islands

Photo: Jerome Poncet.

Printed by the Falkland Islands Government Printing Office

Maps, text layout and design by Sally Poncet.
## CONTENTS

Abstract .................................................................................................................. 1

Introduction .......................................................................................................... 2

Historical Biological Information ..................................................................... 3

Survey Objectives ................................................................................................. 3

Logistics ................................................................................................................ 4

Methods ............................................................................................................... 5

Results and Discussion ....................................................................................... 7

- Cruise Track ..................................................................................................... 7
- Survey Operations ............................................................................................. 7
- Seabird Distribution and Abundance Summary .............................................. 8
- Seabird Habitat Summary ............................................................................... 9
- Fur Seal Distribution and Abundance ............................................................... 10

Navigation Summary ......................................................................................... 11

Seabird Species Account .................................................................................... 12

Island Account .................................................................................................... 18

Conclusions and Recommendations .................................................................. 33

Acknowledgements ............................................................................................. 34

South Sandwich Islands Tables of Results ....................................................... 35

- Survey Operations Diary ............................................................................... 35
- Seabird Population Estimates ......................................................................... 40
- Habitat Analysis ............................................................................................... 42

South Sandwich Islands Maps ........................................................................... 43

- Clerke Rocks .................................................................................................... 56
  - Seabird and Fur Seal Account ....................................................................... 56
  - Seabird and Fur Seal Counts ......................................................................... 60
  - Maps ............................................................................................................... 61

References .......................................................................................................... 63
ABSTRACT

The South Sandwich Islands are one of the main breeding grounds for seabirds in the Scotia Sea. A survey in 1964 recorded fifteen probable breeding species of seabirds, and two Fur Seal breeding beaches. The colonies of Chinstrap penguins have been described as the largest in the world, although there have been no seabird distribution and abundance surveys undertaken at the islands, and no counts of Fur Seals since 1964. To determine the approximate size and location of the islands' seabird colonies, a survey was carried out in 1997. The estimated total number of pairs of Chinstraps was 1,285,000, significantly less than the previous estimate of 5 million pairs, and probably less than that of the South Shetland Islands. All other seabird species were censused and their distribution and nesting habitat marked on maps. Also recorded were features of relevance to navigation around the islands, the number of Fur Seals seen, and the distribution and abundance of seabirds and Fur Seals at Clerke Rocks.
I. INTRODUCTION

The South Sandwich Islands are an uninhabited archipelago of eleven volcanic islands, curving through 370 kilometres (200 nautical miles) of the Scotia Sea between latitudes 56°16'S and 59°28'S and longitudes 26°15'W and 28°06'W. Lying on the eastern rim of the Scotia Ridge, approximately 530 kilometres (285 nautical miles) south-east of South Georgia, they are administered by the Government of South Georgia and the South Sandwich Islands as part of the British Dependent Territories.

Since the first sightings by Cook in 1775 and Bellingshausen in 1819, the South Sandwich Islands have been only very infrequently visited. Due principally to their remoteness and inaccessibility, research expeditions to the group have been few and visits ashore brief, except at Thule Island where an Argentine research station, Corbeta Uruguay, was established in 1976 and occupied until 1982, principally for the purposes of meteorological recording. Currently, the most frequent visitors are the fishing vessels that exploit the surrounding territorial waters, and tourist cruise ships which occasionally disembark a small complement of their passengers for a few hours during their Antarctic summer voyages.

Although long recognised as one of the world's most important seabird breeding grounds, very little biological data exist for the South Sandwich Islands. There have been no abundance and distribution studies of the seabird populations that, in terms of biomass, could prove to be unequalled in the Southern Ocean. Penguins reportedly breed here in so great a number that an accurate assessment of their population size could result in significant corrections being applied to their current global population estimates.

The Fur Seal population, virtually eliminated in the 19th century, could possibly be increasing in parallel with the well-documented increases at South Georgia and the South Shetland Islands (Boyd, 1993). A survey of current Fur Seal numbers is necessary in order to confirm this and to monitor future population changes. In addition, confirmation is required of the breeding status, distribution and abundance of Elephant Seals and Weddell Seals in the group.

In view of the paucity of ecological data for the South Sandwich Islands, the Government of South Georgia and the South Sandwich Islands commissioned a wildlife survey in 1996, with the aim of providing a preliminary assessment of the abundance and distribution of seals, penguins and other seabirds of the South Sandwich Islands.

During the course of the survey, it was decided to also examine Clerke Rocks. The seabird population of this remote group of islands, islets and rocks, lying 75 kilometres (40 nautical miles) east-south-east of South Georgia and directly on the route from South Georgia to the South Sandwich Islands, has never been surveyed in detail.

This report presents the results of these surveys.
II. HISTORICAL BIOLOGICAL INFORMATION

Published records of seabird and seal observations date from C.A. Larsen’s 1908 Undine expedition (Larsen, 1908), the 1930 Discovery II expedition (Kemp and Nelson, 1931), the 1956 Protector survey (Wilkinson, 1956, in Holdgate and Baker, 1979), the 1960 Protector survey (O’Gorman, 1961, in Holdgate and Baker, 1979), and the 1964 Protector survey (Holdgate and Baker, 1979). In 1997, geological and seismological field parties from the British Antarctic Survey were stationed at several sites on the islands and botanical and seabird data were collected (pers. comm. A. Morton).

Occasional visits to the South Sandwich Islands by cruise ships and the Royal Navy have provided anecdotal information since the 1970s. Although landings and inshore Zodiac cruising are usually limited by the notoriously bad weather, thick fog and rough seas which prevail throughout the group, there has been confirmation from cruise ship scientists and British Forces personnel of the earlier records of huge colonies of penguins, with population estimates varying from several to many millions of breeding pairs.

Accurate assessments of seal and seabird stocks of the South Sandwich Islands are an important component of any aspect of conservation for the Scotia Sea region. Production of a management plan for the islands, the assessment of fish stocks and their predators in response to the increased level of fishing activity in the area, an evaluation of long-term seabird population trends, all rely on baseline ecological data that to date have not been collated.

Recognising that penguins are among the important top consumers in the Antarctic food web, and that accurate data on their population sizes are crucial to quantifying their role in Southern Ocean ecology and to providing baseline information for future population changes, the Scientific Committee on Antarctic Research (SCAR) in 1976, recommended that censuses of penguin breeding populations be carried out in the Antarctic region. Since then, several major surveys have been completed. The resulting data are presented in the SCAR publication The Distribution and Abundance of Antarctic and Subantarctic Penguins (Woehler, 1993).

However, no surveys were undertaken at the South Sandwich Islands. The paucity of data is acknowledged in the 1993 SCAR publication, which states that "data for the massive [Chinstrap] populations at the South Sandwich Islands are very imprecise; this location should be the primary target for surveys of this species." “Chinstrap and Macaroni estimates may be significantly modified when reliable data are available for the South Sandwich Islands”.

III. SURVEY OBJECTIVES

The 1997 wildlife survey of the South Sandwich Islands had the following objectives:

i) to census the breeding populations of seabirds and seals of the islands
ii) to record the geographical distribution of these seabirds and seals
iii) to record the habitat in which they breed
iv) to obtain photographic records of the islands’ seabird breeding habitat
v) to record coastal and offshore features of relevance to navigation around the islands
vi) to establish possible methodologies for carrying out future ecological surveys in the group
1. Permits

Permission to visit the South Sandwich Islands was granted by the Commissioner for South Georgia and the South Sandwich Islands.

2. Survey Personnel

The planning and operational aspects of the survey, and the supervising of all data recording, was carried out by Jerome Poncet, aboard the yacht Damien II, during the charter period which began on January 15 1997, when the vessel departed Bird Island at South Georgia, and finished on February 15 1997, upon arrival at Stanley in the Falkland Islands. The vessel was owned and skippered by Jerome Poncet, with Nigel Brothers and Catherine Bone assisting as crew from January 15 to January 28.

The recording of seabird, seal and habitat data was carried out by Jerome Poncet, with assistance during the first half of the survey (January 22 to January 28) from Nigel Brothers, Catherine Bone, May-Ann Lea and Rosy Whelan. Photographs (prints and slides) were taken using a Nikon F6 and 50 mm lens and a Canon EOS 650 and a 35/520 lens by Nigel Brothers, Catherine Bone and Jerome Poncet. Plotting of soundings and offshore navigational features was carried out by Jerome Poncet, who was responsible for the planning of the survey route and the vessel's operation at all times.

3. Logistics

Survey work of any nature at the South Sandwich Islands is limited by the high frequency of depressions and gales from all directions, by the lack of adequate anchorages, by low cloud, fog and pack ice, and by exposed coastlines and heavy swell that preclude boat landings. With eleven islands to survey, totalling approximately 230km (125 nautical miles) of coastline and a further 450km (240 nautical miles) between islands, a small vessel was identified as being able to provide the flexibility necessary to maximise weather-dependent surveying opportunities.

The use of small survey vessels as inshore work platforms from which scientists can work in relative speed, comfort and safety, has already been proven to be a most efficient means of collecting data for broad-scale surveys of this nature. Biological coastal surveys in remote areas such as the Antarctic Peninsula and South Georgia have already been successfully carried out by survey teams stationed aboard a small vessel capable of functioning as an independent unit at all times.

The survey vessel employed during the South Sandwich Islands survey was Damien II, a 15 metre steel-hulled motor-schooner, with a retractable keel allowing access to shallow inshore waters and anchorages during surveying. Certified by Bureau Veritas and equipped with life-raft, HF radio and electronic navigational aids, including radar, GPS and depth sounder, this vessel has successfully provided logistics and accommodation for scientists during ten seasons of seabird and seal surveys in the region. Landings were effected using a Mark 1 Zodiac equipped with a 15 HP outboard engine. Portable VHF radios ensured ship-to-store communications for shore parties.
IV. SURVEY METHODS

The area surveyed included all islands and rocks in the South Sandwich Island group. Also surveyed were the previously little-known Clerke Rocks.

The survey took place between January 15 and February 15, at a time when the likelihood of survey work being curtailed by the presence of pack-ice was minimal, and yet early enough to estimate breeding populations of all species (with the exception of Weddell and Elephant Seals), before colonies and nest-sites emptied and chicks fledged. In addition, there were longer hours of daylight, and the possibility of more favourable weather and sea conditions than if the survey had been scheduled earlier in the season.

The survey work involved circumnavigating the numerous islands and islets at Clerke Rocks, and eleven islands and three islets at the South Sandwich Islands, at an average distance of 50m to 100m from the shore in uncharted, usually foul and often shallow waters.

From comparison with similar research methods in South Georgia and the Antarctic Peninsula, it was calculated that approximately seven days would be required in order to carry out a boat survey of the eleven islands at the South Sandwich Islands. However, previous expedition reports (Kemp and Nelson 1931, Holdgate and Baker 1979) suggested that there would be a high probability of survey operations being interrupted by bad weather, high seas, thick fog and possibly pack-ice. Working on this assumption, it was estimated that only one day in three might be suitable for surveying, and therefore it was decided to make full use of the 17 hours continuous daylight whenever possible, and to continue working for as long as the weather permitted. Emphasis was placed on obtaining maximum broad-scale coverage of each island, and moving rapidly on to the next island, transitting overnight when necessary. Thus all locations received about the same degree of survey coverage, regardless of their ecological diversity. Clerke Rocks were surveyed on January 22, and the South Sandwich Islands survey was completed in the six days between January 25 and 30.

Survey work was carried out according to the methods developed aboard Damien II during the past ten seasons of surveying seals and seabirds at the Antarctic Peninsula, the South Orkneys, South Shetlands and South Georgia (Poncet and Poncet 1985, 1987). The location of the colony, nests, or breeding beach was photographed and its position and surface area recorded on the largest-scale map available, these being based on the Falkland Islands Dependencies APC Misc 79 series, 1976, and the 1989 British Admiralty Chart 3593. These maps are presented in the Appendix and show the survey route of Damien II, inshore depth soundings and reefs, the location of seabird and seal breeding populations, and of the various types of ice-free habitat.

The number of seals and pairs of breeding birds were counted, using binoculars when necessary, either from the deck (2m above sea level) or from the crow's-nest (13m above sea level) of the yacht, while steaming at three to four knots and positioned at between 50m and 100m from the shore.

Boat counts of breeding pairs of Chinstrap Penguins (*Pygoscelis antarctica*) were based on a visual estimation of the surface area in a colony that was occupied by a 'primary counting unit' of 100 nests spaced as at incubation. The number of 'counting units' that comprised the entire colony area was then estimated. Previous surveys have shown that such boat counts are accurate to within 15-20% of ground counts (Poncet and Poncet 1985). The precision of these boat counts was considered to decrease as distance from the colony increased, and also as colony size increased. For example, count accuracy for colonies of less than 5,000 pairs viewed 100m offshore was estimated at 20%, while that for colonies of greater than 10,000 pairs was estimated at 30-50%. With practice, it is feasible to estimate the number of breeding pairs directly from the overall occupied surface area (as indicated by guano-stained ground) when viewed through binoculars from up to 200m offshore.

Once penguin chicks enter the 'creche' stage, nests are no longer well defined enough for the above method to be employed, and counts are necessarily of chicks only, although with
practice, an estimate of the colony surface area may also be made, based on the area of guano-
stained ground.

At a few locations, Gentoo (*Pygoscelis papua*), Macaroni (*Eudyptes chrysolophus*) and Adelie (*Pygoscelis adeliae*) Penguins breed in small groups scattered among the Chinstrap Penguin colonies, and were not visible from the boat. Accurate estimates of their population size were possible from the shore only, as were those for Brown Skuas (*Catharacta lomnbergi*), Antarctic Terns (*Sternavittat*) and Dominican Gulls (*Larus dominicanus*). Opportunistic landings were carried out in order to confirm the presence of breeding species and to calibrate the boat counts. Sightings of Wilson's Storm Petrels (*Oceanitos oceamicus*) and of suitable breeding habitat for this species, were also recorded, but insufficient data were available for estimating population size.

Estimates of numbers of pairs of the cliff-nesting species Antarctic Fulmar (*Fulmarus glacialisoides*), Cape Petrel (*Daptioncapensis*) and Snow Petrel (*Pagodromanea*), were made by identifying occupied nest-sites through binoculars from the boat, generally at a distance of 50m to 100m offshore. At the time of the survey, adults of these three petrel species were feeding chicks on the nest, so that both chick and adult were visible indicators of nest-sites. However, it was not possible to estimate the number of abandoned nest-sites, and field counts are therefore inferior to the maximum breeding population at incubation. Count precision for the larger colonies of over several hundred pairs of Antarctic Fulmars, was considered to be 40%; otherwise count precision for these three species was generally considered to be 5-10%.

Estimates of breeding pairs of Blue-eyed Shags (*Phalacrocorax atriceps*), based on accurate counts of occupied nests, were considered to be accurate to 5%. 


V. SURVEY RESULTS AND DISCUSSION

1. Survey Cruise Track

The route of Damien II during the course of the survey is shown on Figs. 1-14. The survey period commenced on January 15 in South Georgia, after a rendez-vous with RV Golden Fleece in order to transfer crew and embark the survey team. Customs were cleared at Grytviken on January 20, and final departure from South Georgia was on January 21 from Larsen Harbour at the south-east end of South Georgia.

From Larsen Harbour Damien II proceeded to the Clerke Rocks, 75km (40 nautical miles) east-south-east of South Georgia. The Fur Seal population of this group had been surveyed in December 1990 by scientists from the British Antarctic Survey aboard Damien II during the course of a Fur Seal survey of South Georgia, and brief notes made of the seabird colonies, but no detailed census of the latter was carried out. In the 1997 survey, all the islets and rocks were circumnavigated and seabird and seal populations censused. The Clerke Rocks survey data and maps are detailed on pages 57-62.

From Clerke Rocks, a course was steered to the southernmost island in the South Sandwich Islands, a distance of 650km (350 nautical miles), where surveying began on arrival on January 25. In chronological order, the following islands and rocks were surveyed between January 25 and January 30: Thule Island, Cook Island, Bellingshausen Island, Freezland Rock, Wilson Rock, Grindle Rock, Bristol Island, Montagu Island, Saunders Island, Vindication Island, Candlemas Island, Visokoi Island and Zavodovski Island.

On completion of the survey on January 30, a course was steered from Zavodovski Island to Grytviken at South Georgia, a distance of 620km (335 nautical miles), arriving there on February 2. The vessel departed from the island on February 8 bound for the Falkland Islands, distant 1352km (730 nautical miles), arriving at Stanley on February 15.

2. Survey Operations

A total of 2071 nautical miles were covered during the 31 day cruise, which commenced at Bird Island, South Georgia on January 15 and ended at Stanley, Falkland Islands on February 15 1997. All islands and islets in the Clerke Rocks group and the South Sandwich Islands were visited, and with the exception of Leskov Island, all were circumnavigated close inshore, with landings on Thule and Candlemas Islands. Survey details, including distance travelled and weather, are listed in Table 1.

An analysis of survey time and distances covered is shown in Table 2. During the South Sandwich Islands survey, a total of 346 nautical miles (640km) were travelled, of which 132nm (244km) involved coastline surveying and 214nm (396km) were on passage between islands. 92% of the South Sandwich Islands' 216km coastline was surveyed (see Table 5).

There were about 17 hours of continuous daylight (from 0600-2300 GMT) if skies were clear, and 15 to 16 hours (0600-2200 GMT) in overcast conditions. Survey conditions were excellent for three consecutive days, with light variable winds, slight seas and good visibility, during which time 8 of the 11 islands were surveyed i.e. Cook, Bellingshausen, Montagu, Saunders, Vindication, Candlemas and Visokoi Islands.

The vessel's average speed while surveying was three knots, and 5.5 knots while on passage. Thus about 6 to 7 kilometres of coast were surveyed every hour. 42 hours were spent surveying from the boat (including back-tracking and re-surveying); another 10 hours spent doing shore counts), and 39.5 hours on passage (Table 2). A total of 135 hours (5.6 days) was spent at the islands, of which only 10% (14 hours) were unsuitable for surveying due to gale-force north-west to south-west winds experienced at Thule Island. A north-east gale at Zavodovski Island
was less disruptive, since survey work along the east weather coast was completed before conditions became too difficult to work in.

The weather and sea state during the survey period were possibly exceptionally favourable compared with that recorded during past expeditions (Kemp and Nelson 1931; Holdgate and Baker 1979). By working as long as possible during the 17 hours daylight, and by motoring overnight to the next survey location, full advantage was taken of both weather and logistical opportunities. However, there were several occasions when boat survey work was hampered by poor visibility due to low cloud, fog, failing light or a ground cover of snow (which camouflaged cliff-nesting petrels).

Poor visibility was the most significant limiting factor where field work was concerned, since it adversely affected the quality of the counts more than did high winds and seas, and with more frequency. Fortunately, there was no ice to contend with, although this could be a problem in other seasons, when access close inshore may be blocked by fields of floating ice in the form of pack ice, bergy bits and bergs that drift north past the islands from the Weddell Sea.

3. Seabird Distribution and Abundance

Fourteen species of seabirds are known to breed at the South Sandwich Islands. Another two species (Dove Prion and Black-bellied Storm Petrel) are probable breeders. This survey's total seabird population estimates for the South Sandwich Islands are listed in Table 3. Estimates of the seabird populations of each island in the South Sandwich Island are listed in Table 4. Nests counted or the number of pairs estimated, the location of each colony surveyed, and the surface area occupied by Chinstrap colonies, are shown in Figs 2-12. Also shown on the maps are the areas of level and/or gently sloping ice-free ground, and steep rock cliffs.

Chinstrap Penguins were the most abundant species on the South Sandwich Islands. Colonies were seen on all islands except Leskov Island and Wilson Rock, and the total population was estimated to be 1,285,000 pairs (minimum 1,250,000, maximum 1,750,000 pairs). Of note is the fact that the population was also estimated to be 1,250,000 in 1983, when G. Wilson (1983) collated all available population data. A second estimate of 5,000,000 pairs appeared in 1984 (Croxall et al. 1984), and has been cited in many subsequent publications, resulting in an accepted global estimate of 7,490,000 pairs (Woehler 1993).

At 1,285,000 pairs, the South Sandwich Islands' Chinstrap population is slightly less than that of the South Shetland Islands. The latter has been estimated variously at 1,623,442 pairs (Woehler 1993) and 2,068,530 pairs (Marchant & Higgins 1990). The Chinstrap population at the South Orkney Islands was estimated to be a minimum of 600,000 pairs in 1983 (Poncet and Poncet 1985), and that of the Antarctic Peninsula 78,000 pairs (Woehler 1993). Thus the current survey's data significantly decrease the 1984 global population estimate of 7,490,000 pairs, and it would now appear that the total world population of Chinstrap Penguins could be between 3,500,000 and 4,500,000 breeding pairs.

The second most abundant species was the Antarctic Fulmar, with 90,000 pairs. They nested on cliffs up to 200m altitude on all islands except Bellingshausen and Zavodovski Islands. The largest concentrations were on Visokoi (26,000), Montagu (20,000) and Cook Islands (14,000). The number of pairs of Wilson's Storm Petrels nesting here may also be in the order of many thousands. They probably nest on every island in the group, but it was not possible to census the population.

All other seabird species nested in much smaller numbers. Cape Petrels (9,000 pairs) and Snow Petrels (4,000 pairs) were widely distributed along the cliffs of all islands but rarely in groups of more than a hundred pairs. Southern Giant Petrels were seen on Candlemas and Zavodovski Islands, and it is possible that they also nest on Bellingshausen Island. Based on the size of the population at Candlemas Island - 1,500 pairs (pers. comm. A. Morton) - it is estimated that the
total South Sandwich Islands population could be 3000 pairs. Similarly, large numbers (340 pairs) of Brown Skuas were reported nesting on Candlemas Island (pers. comm. A. Morton) and from this, the islands' total population is estimated to be about 1000 pairs.

Gentoo, Adelie and Macaroni Penguins breed adjacent to or among the large colonies of Chinstraps, and unless shore counts were carried out they were usually not visible from the boat. In this survey, Gentooos were recorded breeding on Thule and Candlemas Islands; they probably also nest on Visokoi, Saunders and Zavodovski Islands (Holdgate and Baker 1979). The total population is estimated to be 3000 pairs. Adelies were recorded on Thule, Cook, Bellingshausen and Candlemas Islands, and they also have been reported previously from Saunders, Visokoi and Zavodovski Islands (Holdgate and Baker 1979). Their total population is estimated to be 10 000 pairs. Macaroni Penguins were seen on Thule and Candlemas Islands, and they probably also breed in small numbers on Bellingshausen, Montagu, Vindication, Visokoi, and Zavodovski Islands, with total population of 3000 pairs. In recent years, a few pairs of King Penguins have been reported on Zavodovski Island (pers. comm. P. Prince).

Dominican Gulls nest in small numbers at only a few sites around the islands. A possible explanation for this may have been given by Holdgate and Baker (1979) when they suggested that the lack of sheltered coastal areas and gently shelving shores, the exposure of the islands to heavy seas and storms, and the shortage of shelving reefs below the reach of tides and of surface ice scour, could limit the abundance and diversity of shallow-water fauna, which in turn may determine the amount of suitable feeding habitat available to inshore- and shore-feeding seabirds. Dominican Gulls feed almost exclusively on limpets on the Antarctic Peninsula (Pannelee 1992), and it is probable that the species' distribution and abundance at the South Sandwich Islands parallels that of limpets, whose population may well be limited by the harsh littoral environment.

Antarctic Terns, Dove Prions and Black-bellied Storm Petrels were seen during the survey, and all are assumed to be breeding at the islands. Antarctic Terns were seen in groups of up to 100 in suitable nesting habitat on several islands, and Dove Prion remains have been found previously on Leskov and Bellingshausen Islands (Holdgate and Baker 1979). Burrows in scree were noted on the former island, and it is likely that this species breeds in small numbers at several other locations in the group, as may the Black-bellied Storm Petrel which was sighted close inshore during the survey.

Blue-eyed Shags nested in small isolated colonies on rocky islets and headlands at only three islands in the group. It may be that the islands' population is limited in some way, probably by food resources: suitable colony sites are plentiful and on the basis of this species' distribution elsewhere (Poncet and Poncet in prep.), it would not have been surprising to find one or more colonies on each island.

4. Seabird Habitat

The geographical area known as the South Sandwich Islands consists of vast expanses of water and only a tiny fraction of land. The islands' total surface area is 27 760 hectares, of which only 4315ha are exposed rock, the remaining 85% being covered in ice, glaciers and snow-fields. About half of this ice-free area is in fact steep cliff, leaving little over 2200ha of level to gently sloping ground for all non-cliff dwelling species to nest on. Similarly, the total coastline length of the islands is only 216km, of which a mere 146km are ice-free and offer potential breeding sites for seabirds. With somewhere between 1 300 000 and nearly 2 000 000 penguins breeding at the islands, and over 100 000 pairs of cliff-nesting petrels, most of these ice-free areas are very densely populated.

Table 5 shows the surface area and coastline length, the area of all ice-free ground and of level and/or gently sloping ice-free ground, the length of ice-free coastline and of steep, high rock cliff coastline, and the number of pairs of Chinstraps and Antarctic Fulmars, for each island in the group. Figs. 2-12 show the areas of ice-free ground and ice-covered ground at each island.
The islands are actively volcanic, with relatively recent or current eruptions and fumarolic activity evident at 8 of the islands. During this survey, plumes of vapour were seen issuing from the summit craters of Saunders, Candlemas, Bellingshausen and Zavodovski Islands, and dense vapour and yellow deposits were seen at fissures on the lower slopes of the latter two islands. Over long periods of time, some of the areas utilised by seabirds would no doubt have been destroyed or significantly modified by violent volcanic eruptions, and breeding birds killed at nest-sites. However, these impacts would be of a localised nature only, and it is unlikely that they would have any long-term effect on the total seabird population.

The survey confirmed the suggestion made by Holdgate and Baker (1979), that the differences between the bird faunas of different islands may be related to differences in their suitability as breeding habitats (Table 5). Predictably, those islands with little level ice-free ground and a sheer cliff coastline ie Leskov, Cook and Bristol Islands, have the smallest, or no, penguin colonies. Those islands with gently sloping lava plains extending inland 500m or more from easy landing beaches ie. Zavodovski, Candlemas, Saunders and Bellingshausen Islands, have the largest Chinstrap colonies. Some lava plains rise gently from boulder or sand beaches to less than 50m altitude, as on parts of Candlemas and Saunders Islands. Others are perched atop 10m to 20m high lava cliffs, with access from the sea through steep gullies, as on parts of Bellingshausen and Zavodovski Islands. Colonies are scattered patchily on these lava plains. On heavily glaciated islands such as Thule, Cook Montagu, and Visokoi Islands, colonies are confined to rocky headlands and adjacent slopes, with access from the sea across rock platforms or up steep boulder slopes. Very steep slopes are generally not occupied by penguins. Not all suitable habitat is occupied, and this was so throughout the islands, both on the lava plains and on the rocky headlands. These ice-free plains and headlands also provided nesting habitat for Brown Skuas, Southern Giant Petrels, Dominican Gulls and Antarctic Terns.

Of the 146km of total ice-free coastline in the islands, there are 82km of steep or sheer cliff. Islands with extensive coastal cliffs such as Cook, Montagu and Visokoi Islands, had the largest colonies of cliff-nesting species - Antarctic Fulmars, Cape Petrels and Snow Petrels. Exceptions were Thule Island (3500 pairs of Antarctic Fulmars for 10km of cliff coastline compared with 14 000 pairs on Cook Island on 11km of cliff), the north coast cliffs of Bellingshausen Islands and the west coast cliffs of Zavodovski Island, where no fulmars were recorded. Possible explanations for this are the vulnerability and instability of cliffs fringed with over-hanging glaciers and ice-falls which, during the survey were seen to break off and dislodge entire rock faces, destroying nest-sites and birds; the lack of suitable shoulder and ledge habitat that fulmars require when landing; and volcanic emissions which may discourage birds from nesting on otherwise suitable habitat such as the west coast cliffs of Zavodovski Island. Islands such as Saunders and Candlemas Islands, with few coastal cliffs, and none over 50m altitude, had very few Antarctic Fulmars.

Antarctic Fulmars nested generally on the higher cliff sections, from about 50m to 200m altitude, and at many localities nest adjacent to Snow Petrels. Cape Petrels were recorded on the lower cliff sections up to about 50m above sea level. The ledges on the 10m to 15m high lava cliffs typical of much of the coastline of Saunders and Candlemas Islands, and the low cliffs of rocky headlands and points on Visokoi, Montagu and Thule Islands, appeared to be their preferred habitat. Snow Petrels nested on narrow ledges, in crevices and under rock overhangs at all altitudes up to 400m, and were able to utilise habitat that was unsuitable for Antarctic Fulmars, such as the north coast cliffs of Thule Island.

The boulder, scoria, scree, cinder and ash slopes that are so common throughout all the islands, provide ideal habitat for Wilson's Storm Petrel and Dove Prions. Burrows, possibly of the latter species, have been found on Leskov Island in moss patches, and it is probable that similar habitat exists on Bellingshausen Islands, and possibly Zavodovski, Saunders, Candlemas and Vindication Islands.
5. Fur Seal Distribution and Abundance

Relatively few Fur Seals were seen during the survey, partly because the rocky beaches on which they breed were often difficult to see from the boat, and partly because there were simply very few seals. No Fur Seals were observed swimming offshore, and none were seen in the water close to known breeding beaches.

Several hundred Fur Seals were seen on the Hewison Point shoreline of Thule Island, with one pup reported earlier in the season, and about 100 non-breeding animals were seen at Beach Point, also on Thule Island. 20 animals were seen on the two boulder beaches on the south coast of Bellingshausen Island, but it was not possible to determine whether pups were present. Several non-breeding animals were seen on Freezland, Wilson and Grindle Rocks. Fur Seals were seen at Sombre Point, on the coast south-west of Nattrass Point and on the Cordelia Bay beach on Saunders Island. 16 pups were reported from Zavodovski Island but no location given (pers. comm. N. Brothers).

Holdgate and Baker (1979) recorded two main breeding groups in the South Sandwich Islands in 1964, one of 538 pups on Irving Point on Visokoi Island, the other of 294 pups at Clapmatch Point on Candlemas Island. Neither of these groups were seen from the boat during this survey, probably because they were hidden behind rocks on a coastline that is not easy to examine at close quarters from the sea due to swell and numerous uncharted rocks.

Holdgate and Baker (1979), in extrapolating the documented increase of Fur Seal at South Georgia in the 1960s, predicted that the Fur Seal population of the South Sandwich Islands could number some tens of thousands of animals by the end of the century. If this population expansion had taken place, then far more animals would have been observed during this survey, both ashore and in the water, and it therefore would appear that the Fur Seal population is no larger than it was thirty years ago.

Small numbers of Elephant Seal were seen: 30 animals at Hewison Point, 20 at Beach Point on Thule Island; 10 on the south coast beach of Bellingshausen Island, and a few on the Cordelia Bay beach at Saunders Island. No weaned pups were seen. Examination of potential breeding beaches was difficult from the boat, with the exception of the long beach at Cordelia Bay on Saunders Island. However, it did not seem likely that Elephant Seals were breeding at the South Sandwich Islands in any great number. A total of 20 Weddell Seal and 5 Leopard Seals were also seen around the islands.

6. Photographic Record

Approximately 120 prints and 72 slides showing coastline views of islands and seabird breeding habitat have been catalogued.

7. Navigation

The current 1989 Admiralty Chart 3593 is incomplete, although the coastline outlines are generally fair. However, there are conspicuous gaps in the soundings, and the existence of many uncharted rocks, both above water and awash, as well as shoal areas, makes navigation around the islands hazardous. For a small vessel, most dangers lie within a distance of at 0.5nm from shore, with the exception of the breaker seen in Douglas Strait which lies directly on the route of any vessel intending to transit the strait from the north. Observations relating to navigation around each island in the group are included in the Island Account, pages 18-32.

Due to the volcanic nature of the islands, changes in coastline topography and depths are probably significant and frequent, due to submarine eruptions, uplifting or subsidence of the ocean floor and shorelines, as well as the more obvious volcanic eruptions on shore. Coastline descriptions and charts should be read with caution.
VI. SEABIRD SPECIES ACCOUNT

**King Penguin** *Aptenodytes patagonicus*

King Penguins reportedly breed in small numbers on Zavodovski Island (pers. comm. P. Prince). Historical records indicate that this species was first sighted in the islands in 1830, with a second possible subsequent sighting in 1930 (Holdgate and Baker 1979). No birds were seen during this survey.

**Gentoo Penguin** *Pygoscelis papua*

The total Gentoo Penguin population at the South Sandwich Islands is estimated to be approximately 3000 pairs (or a minimum of 2500 and a maximum of 5000 pairs), nesting on five islands. All known colonies are either adjacent to or in association with Chinstrap colonies.

The largest colony of Gentoo seen during the survey was at Hewison Point on Thule Island, where an estimated 2000 pairs nested among a large colony of Chinspraps. A. Morton (pers. comm.) counted 190 pairs on Candlemas Island, and colonies have also been reported from Visokoi, Saunders and Zavodovski Islands (Holdgate and Baker 1979), but none of these were visible from the boat, either because groups were too far inland or because they were obscured by Chinstraps.

**Adelie Penguin** *Pygoscelis adeliae*

Adelie colonies have been previously reported from Candlemas, Zavodovski and Montagu Islands, with suspected colonies on Saunders and Bellingshausen Island (Holdgate and Baker 1979). The total population has been estimated at 30 000 pairs (Croxall et al. 1984).

This survey estimated 10 000 breeding pairs of Adelies (minimum 8000, maximum 15 000 pairs). Colonies were seen on Thule Island at three localities (Hewison Point, Beach Point, Herd Point), on Cook Island at one locality (1km north of Reef Point, plus a possible colony 1km east of Reef Point) and at Bellingshausen Island where dense groups of fledged chicks were observed on the south coast beaches. All were adjacent to or in association with Chinstrap colonies, but were not visible from the boat unless situated close to the coast and adjacent to rather than among the Chinstrap colonies. Fledging Adelie chicks were more conspicuous when they formed creches and approached the beach areas, as on Bellingshausen Island. 930 pairs were counted on Candlemas Island in January 1997 (pers. comm. A. Morton).

A more precise census, carried out earlier in the season before chicks leave the nest, is needed to improve the accuracy of the survey's estimate, and in particular the size of the colonies on Zavodovski and Bellingshausen Islands.

**Chinstrap Penguin** *Pygoscelis antarctica*

Chinstrap Penguins are the most abundant seabird species in the South Sandwich Islands. In this survey, they were recorded breeding on all islands in the group, with the exception of Leskov Island and Wilson Rock. Anecdotal observations have frequently referred to "millions" of penguins and certainly the largest colony, on Zavodovski Island, is an impressive sight. However, this survey estimated the total population of the South Sandwich Islands to be 1 285 000 pairs (minimum 1 250 000, maximum 1 750 000 pairs). The largest Chinstrap colony was on Zavodovski (750 000 pairs), followed by Candlemas (150 000), Saunders (100 000), Visokoi (96 000), Thule (71 000), Vindication (46 000), Bellingshausen (36 000) and Montagu (20 000), with smaller colonies on Cook Island and Bristol Island, Freezland and Grindle Rocks.
Chinstrap colonies were systematically seen wherever there was suitable nesting habitat, this being typically on level or gently sloping ice-free ground, rather than on steep rock inclines. Some of the larger colonies were situated on lava plains that rose gently from sea level to less than 50m altitude with easy access from the sea across a boulder beach (as at Kraken Cove and Sea Serpent Cove on Candlemas Island, Beach Point on Thule Island, and the south coast colony on Bellingshausen Island) or across a sand beach (as in Cordelia Bay on Saunders Island). Other large colonies, also situated on gently sloping lava plains, were above the shore atop 10m to 20m high lava cliffs, with access from the sea through steep gullies (as on the east coast of Zavodovski Island, at Allen Point on Montagu Island, and at the west coast colony on Bellingshausen Island).

On heavily glaciated islands (eg. Thule, Cook and Montagu Islands), colonies were usually confined to rocky headlands with access from the sea across rock platforms or up steep boulder slopes. Only one colony (on Cook Island) was observed on steep ground rising directly from the shore. On the west coast of Saunders Island in the Ollivant Point area, a few colonies "spilled over" on to ash-covered glaciers from the adjoining rocky terrain. Less commonly, colonies were also seen on offshore rocks and islets, one off the north coast of Montagu Island, and the others on Freezland and Wilson Rocks off Bristol Island. Where the coast was very steep, with no beach area, there were no penguin colonies (as at Leskov Island and Grindle Rock).

The large colonies that occupy the lava plains at Zavodovski, Candlemas, Saunders and Bellingshausen Islands extend inland up to 500m or more on gently sloping ground. Breeding groups are scattered patchily over this terrain, with large expanses of unoccupied ground. Colony size did not appear to be limited by a shortage of suitable breeding habitat. These large Chinstrap colonies also included small numbers of Gentoo, Adelie and Macaroni Penguins.

Curiously, Larsen remarked that Macaroni Penguins were more numerous than Chinstraps on Zavodovski Island in 1908. Holdgate and Baker (1979) recorded only 5000 to 6000 pairs of Chinstraps at Bellingshausen south coast colony in 1964, whereas this survey estimated the population to be 30,000 pairs. These observations may indicate that the Chinstrap population of the South Sandwich Islands fluctuates markedly, or may even have increased over the past 40 years. However, neither the notes nor the counts are accurate enough to be of more than anecdotal value.

**Macaroni Penguin** *Eudyptes chrysolophus*

Few Macaroni Penguins were seen during this survey, with the exception of a group of 300 adults at Hewison Point on Thule Island, scattered among the Chinstraps. No Macaroni Penguins were seen from the boat, either because groups were too far inland or because they were obscured by Chinstraps.

This species has previously been reported among the large Chinstrap colonies on Bellingshausen, Montagu, Saunders, Vindication, Candlemas, Visokoi and Zavodovski Islands (Holdgate and Baker 1979). In November 1908, Macaronis were reported as being more numerous than Chinstraps on Zavodovski Island (Larsen 1908), but this has not been the case on subsequent visits. In January 1997, 1128 pairs were counted on Candlemas Island (pers. comm. A. Morton).

The total population of the South Sandwich Islands was estimated to be 3000 pairs (minimum 2000, maximum 5000 pairs), but a more detailed census is necessary to improve the accuracy of this estimate. However, it is unlikely that the total population exceeds several thousand pairs.
Southern Giant Petrel *Macronectes giganteus*

Southern Giant Petrels were seen on Candlemas and Zavodovski Islands during this survey. A. Morton (pers. comm.) counted 1516 pairs on Candlemas Island in January 1997, and it is quite possible that at least this number nest on Zavodovski Island. Adults were also seen ashore on Bellingshausen Island, but a landing would be necessary to confirm breeding. The large expanses of gently sloping ground adjacent to the Chinstrap colonies at Blackstone Plain on Saunders Island, offered a similar habitat to that at Candlemas Island, and it is possible that this species may also nest on Saunders Island.

The total population for the South Sandwich Islands is estimated to be 3000 pairs (minimum 2000, maximum 4000 pairs), considerably more than the previous estimate of 800 pairs (Croxall *et al.* 1984).

Antarctic Fulmar *Fulmarus glacialisoides*

Antarctic Fulmars were found nesting on all islands except Bellingshausen and Zavodovski Islands. Nest-sites were on ledges and stable shoulders consisting of coarse scree and boulder piles situated on cliff faces, generally from about 50m to 200m altitude, but birds were occasionally seen on nests almost at sea level and also on the higher cliffs between 200m and 400m altitude. At many localities, there were a few Snow Petrels seen nesting among the fulmars, and on the lower cliff sections, Cape Petrels were also present.

Although the majority of occupied nest-sites were visible from the boat, count accuracy decreased from about 95% to 70% for colonies of over 1000 nests. Because it was not possible to calculate nest failure, the actual nest counts are underestimates of the number of breeding pairs, and this was taken into consideration when calculating the overall total population size, estimated to be 90 000 pairs (ranging from 80 000 to 110 000 pairs). This is considerably lower than the 1984 population estimate of 1 000 000 pairs (Croxall *et al.* 1984).

Nest counts in this survey were in fact counts of both unattended chicks and adults brooding small chicks, the light grey plumage contrasting conspicuously against the dark rock. Where birds nested in groups of several thousands, nest-sites were often indicated by patches of green moss that grew on the guano-enriched rocks adjacent to nests. The difficulties of censusing cliff-nesting petrels when there is snow on the ground, became apparent during the survey when a light covering of snow along the north coast of Cook Island camouflaged birds on nests. Fortunately, this was the only snow fall experienced during the survey.

The largest concentration of Antarctic Fulmars was seen at Allen Point on Montagu Island where an estimated 12 550 pairs nested. Other large colonies were seen at Morrell Point on Thule Island (3000 pairs), Reef Point on Cook Island (9000), Turmoil Point on Bristol Island (5700), Finger Point (9300), Wordie Point (3700) and Mikhaylov Point (5600), all on Visokoi Island.

At some islands, the abundance of Antarctic Fulmars was proportional to the length of ice-free high cliff coastline. For example, Montagu and Visokoi Islands, both with 14km of ice-free cliff coastline, have an estimated 20 000 and 26 000 pairs respectively; whereas on Saunders and Candlemas Islands, where there are few coastal cliffs, and none over 50m altitude, very few birds were recorded.

Abundance was also related to the availability of suitable cliff substrate. Thule Island has 10km of cliff coastline, but relatively few Antarctic Fulmars were seen. This was thought to be due to the constant erosion of substrate, where over-hanging glaciers and ice-falls frequently dislodge entire rock faces, steep slopes of unstable ash are continually avalanching. Safe stable nest-sites are scarce. The sheer cliffs on the north coast of Bellingshausen Island and along most of the Thule Island coast, were also sparsely populated, probably because of a lack of the suitable shoulder and ledge habitat that this species requires when landing.
Erosion of substrate also affects adult and chick mortality. On three occasions during the survey, rock falls, landslides and an avalanche from an over-hanging glacier killed a total of 50 adult Antarctic Fulmars and one Snow Petrel chick on nests. Volcanic activity may also influence abundance, and could explain the absence of birds along the 12km of cliff on Zavodovski Island's west coast. These cliffs appeared to offer ideal nesting habitat, but were constantly enveloped in steam and dense clouds of gases emanating from a fissure lying 1.5km south of Stench Point. It is possible that these emissions render the area uninhabitable.

Cape Petrel *Daption capensis*

Cape Petrels nested on all islands and islets in the South Sandwich Islands. Although the total population is relatively small and estimated at only 9000 pairs (minimum 8000, maximum 11000 pairs), nest-sites were well-distributed along most coastlines. This survey's estimate agrees with the 1984 minimum estimate of 10000 pairs, rather than its maximum estimate of 100000 pairs (Croxall et al. 1984).

Cape Petrels appeared to occupy the same type of habitat as Antarctic Fulmars (i.e. ledges and stable shoulders consisting of coarse scree and boulder piles), but their nest-sites were typically at lower altitudes than the latter's, being usually found between sea level and 50m altitude. The 10m to 15m high lava cliffs typical of much of the coastline of Saunders and Candlemas Islands, and the small cliffs of the rocky headlands and points of Visokoi, Montagu and Thule Islands, appeared to be their preferred habitat, with over 1000 pairs counted on each island. Breeding groups were loosely colonial with up to 50 nests scattered sparsely along a cliff section. However, on Visokoi Island there were a few groups with between 200 and 300 nests located within a relatively small area.

In many areas, patches of orange-coloured lichens covered the rocks in close proximity to breeding birds. These patches, in addition to the contrasting black and white plumage of the birds, conspicuously indicated the position of nest-sites, most of which were visible from the boat. Counts of nests were estimated to be accurate to about 5-10%, but because it was not possible to calculate nest failure, these nest counts are underestimates of the number of breeding pairs, and allowance was made for this when calculating the overall total population size.

Snow Petrel *Pagodroma nivea*

Snow Petrels nested in inaccessible rock crevices and under overhangs at all altitudes from sea level up to 400m. They were the most difficult species to census from the boat, as many nests were hidden from view. All nest counts are minimum breeding pair estimates. A total of 3340 nests were counted, and the total South Sandwich Islands population was estimated to be at least 3500 pairs, and possibly as high as 5000 pairs. In fact, a more detailed census may well reveal that even 5000 pairs is an underestimate. Previously, the population has been stated to be approximately 1000 pairs (Croxall et al. 1984).

Several hundred pairs were estimated on Cook, Bellingshausen, Bristol, Montagu and Candlemas Island. Up to 100 pairs were estimated on Vindication, Visokoi, Leskov and Zavodovski Islands, and approximately 10 pairs on Saunders Island, Freezland, Wilson and Grindle Rocks. Nests were sparsely scattered on cliffs, sometimes adjacent to Antarctic Fulmars and Cape Petrels. Snow Petrel remains have been found adjacent to Brown Skuas nests (Holdgate and Baker 1979) and it is possible that Snow Petrels form an important part of the latter's diet.
**Dove Prion** *Pachyptiladesolata*

A few Dove Prions were seen at sea during the survey, but breeding was not confirmed. In 1964, prion remains were found adjacent to Brown Skua nests on Bellingshausen Island, and burrows in scree were seen on Leskov Island (Holdgate and Baker 1979). There may be several hundreds or even several thousands of breeding pairs, but landings are necessary to confirm this, and to determine its status on Zavodovski, Candlemas and Saunders Islands, where there appears to be an abundance of suitable breeding habitat.

**Wilson’s Storm Petrel** *Oceanitesoceanicus*

The survey did not confirm breeding of this species, although adult birds were seen flying over suitable nesting habitat at many locations on the islands, and breeding has been confirmed on previous visits (Holdgate and Baker 1979).

Birds nest on scree and boulder slopes and on rocky headlands, wherever there is ice-free ground, on probably every island in the group. There are over 4,000 hectares of ice-free terrain in the South Sandwich Islands, of which at least half is potentially suitable nesting habitat. A. Morton, who spent several weeks on Candlemas Island in January and February 1997, estimated the population there to be 'thousands' (pers. comm. A. Morton); Holdgate and Baker (1979) estimated that Wilson’s Storm Petrels were less numerous than Cape Petrels and Antarctic Fulmars. The breeding population has been estimated to be 10,000 to 100,000 pairs (Croxall et al. 1984), but while it is not possible to do more than 'guesstimate', it is unlikely that there are one million pairs, although is no doubt that there may be many thousands, if not hundreds of thousands of pairs.

**Black-bellied Storm Petrel** *Fregattatropica*

It has been suggested that this species possibly breeds at the islands (Holdgate and Baker 1979). In January 1997, A. Morton (pers. comm.) recorded birds possibly nesting on Candlemas Island. A few birds were seen at sea during the survey but apart from recording an abundance of potentially suitable breeding habitat, it was not possible to confirm breeding.

**Blue-eyed Shag** *Phalacrocoraxatriceps*

Blue-eyed Shags were not abundant or widely distributed around the islands. Four colonies totalling 233 pairs were surveyed, two on the north-west coast of Bristol Island, and four on Montagu Island. Another two colonies are known to exist, one near Harker Point on Bristol Island, and the other on Zavodovski Island. An estimate was made of their populations (approximately 30 pairs at the former, and 100 pairs at the latter colony) based on information from prior visits (Holdgate and Baker 1979; pers. comm. N. Cobley). The total South Sandwich Islands population was estimated to be 365 pairs (minimum 300 pairs, maximum 400).

**Snowy Sheathbill** *Chionisalba*

During this survey, a single individual was seen on Freezland Rock off Bristol Island in the vicinity of a small colony of Antarctic Fulmars. There was no indication that this species nested on the islands.
Brown Skua *Catharacta lionbergeri*

Approximately 1000 pairs of Brown Skuas (minimum 700, maximum 2000 pairs) were estimated to nest at the South Sandwich Islands. It was not possible to count pairs from the boat, but based on shore counts at Hewison Point on Thule Island (8-10 pairs in a colony of approximately 60,000 pairs of Chinstraps), and information from A. Morton, it was estimated that skuas nested in small numbers on the rocky headlands and lava plains on nearly all islands, usually in the vicinity of Chinstrap colonies. They were noted as being abundant on Bellingshausen Island in 1964 (Holdgate and Baker 1979), and Snow Petrel and Dove Prion remains were seen here in the vicinity of skua nests. Skuas were also seen on Leskov Island: no penguins breed here, but there are Snow Petrels, probably Wilson's Storm Petrels and possibly a small population of Dove Prions, all of which would be preyed upon by skuas.

The Candlemas Island population, with its 340 breeding pairs and over 300 non-breeding birds (pers. comm. A. Morton), may be exceptionally large for the islands. It is possible that this high number is due to the presence of several large bodies of brackish water - frequently used by skuas for bathing, and around which non-breeding birds concentrate in 'skua clubs' - rather than to the number of Chinstrap Penguins on the island.

Chinstrap eggs and young chicks are no doubt an important component of the Brown Skua's diet in the South Sandwich Islands. Other possibly even more important sources of food are the Snow Petrels and Wilson's Storm Petrels that breed on virtually every island, and to a lesser degree, the small population of Dove Prions. However, there are only a few hundred pairs, (possibly up to 1000 pairs) of Snow Petrels on each island, and even fewer numbers of Dove Prions, and this relative scarcity could be the single most important factor limiting the Brown Skua population at the islands. It is not known whether they forage at sea if food ashore becomes scarce.

**Dominican Gull* Larus dominicanus**

This species nested in low numbers at a few locations in the group, generally in the vicinity of penguin colonies, and probably totalled no more than 200 pairs. During this survey, fledged young were seen on Thule and Bellingshausen Islands, and adults on Cook, Saunders and Zavodovski Islands and Freezland Rock. 14 nests with chicks were counted on Candlemas Island in January 1997 (pers. comm. A. Morton), and adults were seen on Vindication Island in 1964 (Holdgate and Baker 1979).

**Antarctic Tern* Sterna vittata**

Several groups of Antarctic Terns were seen during this survey, on Thule, Visokoi and Zavodovski Islands. There is no shortage of suitable nesting habitat, both on the coast and also on the inland areas of Saunders, Candlemas, Bellingshausen, Vindication and Zavodovski Islands, but breeding was not confirmed. Possibly between 50 and 200 pairs nest at the islands. Elsewhere in its range, this species is often seen feeding in the intertidal zone, but at the South Sandwich Islands, the lack of sheltered coastal shores could limit the terns' foraging opportunities.
VII. ISLAND ACCOUNT

Figs. 2-12 show maps of each island in the South Sandwich Islands, and include seabird colony locations, ice-free and ice-covered areas, and the route of the vessel.

Thule Island

Southernmost of the South Sandwich Islands, Thule Island (Fig. 2) is heavily glaciated, with approximately 95% of its 1500ha being covered in ice and snow. In contrast, over 70% of its 21km length of coastline is ice-free. Of this, 10km consists of rock cliffs and steep ash-covered slopes rising up to 300m above the sea, intersected by glaciers in places. Some of the cliffs are composed of sheer rock faces, particularly on the north coast; others are capped by overhanging glaciers and are subject to frequent ice-falls and avalanches; those on the east coast below Mt Larsen are intersected by steep slopes of loose ash.

There are 57ha of low-lying and undulating to hilly ice-free habitat on Thule Island, situated on the five headlands of Cape Flannery, Hewison, Herd, Beach, and Wasp Points. 90% of this habitat is found at Hewison, Herd and Beach Points, where the island's 71 000 pairs of Chinstraps breed. The largest colony, at Hewison Point, has 60 000 pairs. There was a small colony of 150 pairs at Cape Flannery, but none were seen at Wasp Point.

Approximately 5000 pairs Adelie Penguins and 2000 pairs of Gentoo Penguins were estimated to be breeding at Hewison Point among the Chinstraps. Another 200 pairs of Adelies were recorded at Herd Point, and 20 pairs at Beach Point, both amongst Chinstraps, but further surveys are needed to improve the precision of these estimates, and to confirm breeding of Macaroni penguins, of which several hundred were seen in singles and pairs at Hewison Point but none breeding. This latter species has also been recorded at Hewison Point in previous visits (Holdgate and Baker 1979).

Despite the relatively large area of ice-free habitat that the island's coastal cliffs provide, the availability of breeding sites for Antarctic Fulmars appears to be significantly limited by constant erosion of the substrate. The active overhanging glaciers and associated ice-falls frequently dislodge entire rock faces, and with them, their population of fulmars. The steep slopes of unstable ash are also continually avalanching and very few nests were seen on this substrate. This instability of habitat is reflected in the comparatively low numbers of Antarctic Fulmars, and the fact that no birds were seen in 1964 (Holdgate and Baker 1979). In the present survey, less than 100 pairs were counted on the south-west coast cliffs between Cape Flannery and Herd Point, and fewer than 20 on the east coast cliffs below Mt Larsen, while none at all were seen along the entire north coast, except at Morrell Pt where possibly a colony of 3000 pairs was recorded. However, this is a low-precision count due to the fact that the census was done in poor light. Another survey would be necessary in order to confirm this survey's total Antarctic Fulmar population estimate for Thule Island of 3500 pairs.

The island's total Cape Petrel breeding population was estimated to be 1000 pairs, based on the census total of 865 nest-sites. Overall, this species appeared to be more widely distributed than the Antarctic Fulmar. Nesting sites were usually on low altitude cliffs where glacial activity appeared to be less frequent than at the higher altitude Antarctic Fulmar sites. Two main breeding sites were found, one with 192 nests on the coastal cliffs adjacent to the Chinstrap Penguin colony at Beach Point, and another of 650 nests at Wasp Point. The remaining 23 pairs recorded were scattered along the west coast in the Cape Flannery area and on the east coast below Mt Larsen. It is possible that this species also breeds at Morrell Point.

Snow Petrels nest in inaccessible rock crevices at all altitudes, a habitat that appears to be less favoured by Antarctic Fulmars and Cape Petrels. This feature is reflected in the distribution of the estimated breeding population of 1000 pairs of Snow Petrel of Thule Island, where the 792
nests counted were regularly distributed in small numbers on cliff faces around most of the island’s coastline.

Wilson’s Storm Petrels probably nest in the lava boulder slopes on all of the rock headlands around the island, although no birds were seen in these areas during the survey.

Brown Skuas and Dominican Gulls, both with chicks, were recorded nesting at Hewison and Herd Points adjacent to the Chinstrap colonies. Brown Skuas were also seen at Wasp Point.

Approximately 10 Antarctic Terns, possibly nesting, were seen at the base of cliffs 1km west of Wasp Point.

Twitcher Rock, lying 1km east of Hewison Point, is an ice-free islet with no shore platform and cliffs rising sheer to the 55m high summit. 53 pairs of Snow Petrels were seen on the north face, and another 15 on the south-east face, with 2 Cape Petrels.

Navigation
The coast between Cape Flannery and Herd Point was surveyed from close inshore, generally between 50m and 100m from the coast and depths of between 20m and 30m were recorded. There appeared to be few shoal areas or rock pinnacles, with the exception of the Cape Flannery area, where two submerged rocks, over which water was breaking, were seen. One lies approximately 300m due north of the cape, and the other approximately 300m south-west of the cape. Wasp Point appears to be clear of danger. A submerged reef, indicated by some visible low rocks, lies close off Herd Point.

Ferguson Bay appears to be clear of rocks, and a reasonable anchorage with depths of 5m to 10m was found about 50m off the beach, approximately 500m east of Herd Point. In a north-west gale experienced at this anchorage, it was found that some shelter from wind and swell was afforded by the lee of the land. With the onset of south-westerly winds however, the swell increased and it became necessary to seek shelter on the island’s east coast, the best anchorage being found to be at Beach Point.

Interestingly, it is here on the north-east side of Thule Island in 1832, that Benjamin Morrell in the small sealing schooner Wasp found a good harbour, and this was confirmed during this survey when two nights were spent sheltering here in a south-west gale. The anchorage lies 800m south of Beach Point immediately below the glacier snout, in 12m of water. It was not possible to anchor directly infront of the landing beach at Beach Point, since depths here were 30m close to the shore and thus too deep for anchoring. The plateau on which the anchorage lies, extends from the group of small islets and rocks which lie close offshore from the cliffs below Mt Larsen, and care should be taken when approaching as there are possibly submerged reefs or pinnacles in the area.

The Beach Point anchorage affords good shelter for small and large vessels in all winds from north-west to south-west, being protected to the north from the full force of any westerly swell by a reef of submerged rocks that extends over 1km due east from Beach Point, over which seas break heavily. It is possibly the best anchorage in the South Sandwich Islands group, being superior to the Ferguson Bay anchorage which is exposed to swell and winds from the south quarter.

It is possible to land on the beach on the south side of Beach Point, but despite the protection from the reef, there is usually some swell breaking on shore, rendering landings hazardous at times.

When passing from Beach Point to the north coast of Thule Island, it is necessary to keep at least 0.7nm (1.2km) offshore in order to round Beach Point outside the submerged reef, over which seas are usually breaking heavily. The easternmost point of this reef appears to be clearly indicated by a visible breaker. Another area of breakers is located approximately 1.2nm (2.5km) east of Beach Point, leaving a 1km wide passage, indicated as foul in Admiralty Chart 3593,
between the two reefs. However, depths of 10m to 20m were recorded close east of the last visible breaker when passing through this passage. It is very likely though that other submerged rocks do exist, as evidenced by irregular soundings off Tilbrook Point on Cook Island, and the sighting of an unreported breaker in Douglas Strait. Its GPS position was recorded as 59°24'48"S and 27°15'43"W, and it lay approximately 1.9nm east of Beach Point and 1.1nm north-north-west of Tilbrook Point, more or less on that route most likely to be taken by vessels entering Douglas Strait from the north.

Depths along the north coast of Thule Island from Beach Point to Morrell Point were around 20m when approximately 100m from the shore, and no were breakers sighted. An islet lying approximately 300m east of Morrell Point, was surrounded by a submerged plateau over which the sea was breaking.

From Hewison Point a reef extends 1km due east to Twitcher Rock, but a narrow inshore passage close off Hewison Point, with a minimum recorded depth of 20m, was transitted during the survey. Although there may be submerged rocks in the passage, none were seen breaking, whereas seas were constantly breaking over the reef to the east. Twitcher Rock, approached from the north-west and surveyed from 20m offshore, appeared to be free of dangers on its north, south and east coasts.

Cook Island

Cook Island (Fig. 3) lies at the same latitude as Thule Island, from which it is separated to the west by the 5km wide (2.7nm) Douglas Strait. It is a little larger than Thule Island, occupying 2000ha, of which 120ha are ice-free. It is also heavily glaciated, and rises precipitously to over 1000m altitude with no visible signs of volcanic activity. 12km of its 19km coastline consist of sheer rock cliffs.

There are 2 small areas of rock headland at Reef Point and Resolution Point, both of which appear to be provide suitable breeding habitat for penguins and also Wilson's Storm Petrels, although neither species were seen here during this survey. Visits in 1930 (Kemp and Nelson 1931) and again in 1964 (Holdgate and Baker 1979) recorded no penguin colonies on Cook Island. This survey, however, recorded a small colony of approximately 1000 pairs of Chinstrips, possibly with a few Adelies among them, on steep rock slopes up to about 150m altitude on a small ice-free area lying about 1km north of Reef Point. A small group of Adelies (10 pairs estimated) was seen on a small rock headland on the south coast approximately 1km east of Reef Point but it was not possible to determine if they were breeding.

The survey's census of Cook Island's cliff-nesting seabirds was hindered by snow on the ground and also by thick fog which obscured a 2km section of coastline immediately east of Tilbrook Point. Thus the survey counts for these species are undoubtedly under-estimates of the total breeding populations. Antarctic Fulmars, estimated at 14,000 pairs for the island, were widely distributed, the main concentration being at Reef Point, where 9000 pairs of the island's 12,266 censused nests were seen on the cliff and ridge above the point. 201 pairs of Cape Petrel were counted, for an estimated island total of 250 pairs, and 213 pairs of Snow Petrels for an estimated island population of 300 pairs, both species being scattered regularly around the precipitous coastal cliffs. The former species was seen usually at lower altitudes while the latter was often seen nesting up to 200m above the sea. Inexplicably, no Cape Petrels were seen along the north coast cliffs.

One pair of Dominican Gulls was seen on the north coast, probably breeding. No Brown Skuas, Blue-eyed Shags or Antarctic Terns were recorded.

Navigation

The route taken when surveying lay generally between 50m and 100m offshore, and at this distance no isolated submerged rock pinnacles were observed, although there were breakers off Reef, Tilbrook, Resolution and Longton Points. Depths along the north coast from Tilbrook
Point to Resolution Point varied between 5m to 20m. Breakers extend approximately 200m offshore from Tilbrook Point, and 500m off Reef Point. At Resolution Point there is an inshore passage with 20m depth between the point and a breaker lying approximately 200m offshore. Depths varied along the east coast from 5m to 11m, but the only breaker seen lay close off Longton Point. There was also a short reef extending from the coast 500m south of Longton Point. Along the south coast between Longton Point and Reef Point, depths varied from 9m to 20m when passing approximately 150m offshore, with one breaker sighted close to the coast, approximately 2km west of Longton Point, and one above-water rock lying 1km west of this.

Bellinghausen Island

In contrast to Thule and Cook Islands, Bellinghausen Island is virtually ice-free and displays marked evidence of current volcanic activity (Fig. 4). Thick clouds of vapour and yellow sulphur deposits were visible on the east coast south of Jagged Point, and a constant vapour plume emanated from the island's central summit crater near Basilisk Peak. It is the second-smallest island in the group and occupies only 140ha, of which 130ha are ice-free, with a remnant ice-cap on the crater slopes. Approximately half of the island's 6km rock coastline consists of cliffs generally less than 50m high, while the remainder is a mixture of beach, ash and 5m to 10m high lava cliffs.

The island's total Chinstrap population was estimated to be 36 000 pairs. The vast majority (25 000 pairs) nest along the south coast of the island in dense but sparsely distributed and distinct groups spread over a 70ha lava plain. Most of this plain appears ideal for nesting, yet only a small proportion is utilised. In 1964, the colony was estimated to be between 5000 and 6000 pairs distributed in small scattered groups (Holdgate and Baker 1979). Low cloud prevented observation of the crater slopes above the plain where Chinstraps had been recorded up to 150m above sea level in 1930 (Kemp and Nelson 1931). There were three other Chinstrap colonies: one of 5000 pairs on the west coast stretching nearly 1km north of Hardy Point; another of 5000 pairs on the slopes between Salamander Point and Basilisk Peak; and a small colony of about 300 pairs, mixed with 100 pairs of Adelies, on the rock ledges at Jagged Point.

Large groups of fledged Adelie chicks were seen on the south coast, as well as the small group at Jagged Point, thus confirming Holdgate's observation that this latter species might breed here (Holdgate and Baker 1979).

No Macaroni Penguins were seen during the survey. About 100 pairs were seen on the island in 1964 (Holdgate and Baker 1979), and landing would be necessary to confirm their breeding status.

Three Southern Giant Petrels were seen in the vicinity of the Chinstrap colonies on the south coast, and it is possible that these birds breed here, as they were also seen resting on the southern lava slopes in 1964, although no nests were found (Holdgate and Baker 1979).

Cape Petrels were estimated at 500 pairs, and Snow Petrels at 400. Both species were seen nesting mainly on the west coast cliffs between Salamander Point and Hardy Point, where nearly 400 pairs of the former and over 100 of the latter were recorded. Fog and low cloud obscured the island's crater, where 200 pairs have been recorded nesting on the inner slopes (pers. comm. A. Fothergill). Another 37 pairs of Snow Petrels and 51 of Cape Petrels were seen along the east coast between Salamander Point and Isaacson Point. No Antarctic Fulmars were seen among the Cape Petrels and Snow Petrels, nor in 1964 (Holdgate and Baker 1979), and it seems unlikely that this species breeds on the island.

There is suitable habitat for Dove Prions, but a landing would be necessary to confirm this species presence, first noted in 1964 when the remains of several birds were found in the vicinity of skuas' nests, indicating probably breeding (Holdgate and Baker 1979).
There is also an abundance of suitable scree habitat for Wilson's Storm Petrels, recorded nesting on slopes near Hardy Point in 1964 (Holdgate and Baker 1979).

Brown Skuas and Dominican Gulls with chicks were seen on the south coast. These two species were recorded as being abundant in 1964. Several of the former were seen nesting on the lava slopes south of the crater, and the latter had many nests among the Chinstraps on the south coast.

During this survey, heavy swell prevented a landing, thus precluding the opportunity of surveying in detail the breeding populations of Macaroni Penguins, Brown Skuas, Dominican Gulls and Wilson's Storm Petrels, or of confirming the breeding status of Dove Prions and Southern Giant Petrels. Under good conditions, landings would be possible at Salamander Point (from where Basilisk Peak is accessible) and on either of the two boulder beaches on the south coast close east of Hardy Point.

**Navigation**

Belingshausen Island is separated from Cook Island by the 300m wide Maurice Channel which appears to be clear of danger. Depths of about 10m were recorded when passing between 50m and 100m off the south, west and north coasts. Only one breaker was seen, lying approximately 50m from the coast on the western side of Jagged Point. However, the bay that lies to the south of Jagged Point on the east coast is foul, with a submerged plateau of less than 5m depth and containing numerous breakers extending up to 500m from the coast. The island offers no protection from swell, and there is no small boat anchorage or all-weather landing beach.

**Bristol Island**

This is the second-largest island in the South Sandwich Island group. It is mostly ice-covered, with only 2% of its 8,000 ha being exposed rock (Fig. 5). It showed no signs of volcanic activity when viewed from the sea.

36 km of the island's 45 km coastline is fringed with glaciers, and the 9 km of rock coastline is mostly sheer cliff. There is very little level ice-free ground or rock headlands, with the possible exception of the Harker Point area which was not surveyed. Because this survey did not cover the south coast from Turmoil Point to Trulla Bluff, all population counts are underestimates, and a survey of the Harker Point area in particular is necessary.

This survey recorded 3 small colonies of Chinstraps of 420 pairs (giving a total estimated island population of 450 pairs) on small areas of level ground above 5 m high lava cliffs along the island's north-west coast between Turmoil Point and Fryer Point. None of these have been previously recorded, although Chinstraps were seen on the small rock headland west of Harker Point in 1930 (Kemp and Nelson 1931) and again in 1964 (Holdgate and Baker 1979).

The steep cliffs in the Turmoil Point area provide ideal nesting habitat for Antarctic Fulmars, with 5900 pairs counted at nest sites from sea level up to about 250 m altitude. The total island population was estimated at 7000 pairs.

255 pairs of Snow Petrels nested adjacent to Antarctic Fulmars at Turmoil Point, and a total of 300 pairs was estimated for the island. Additional colonies of both Antarctic Fulmars and Snow Petrels may exist along the unsurveyed south coast.

Few Cape Petrels were seen along the north coast, as suitable habitat was limited. It is likely that this species breeds on the south coast cliffs near Harker Point and the total island population was estimated to be 100 pairs.

Suitable habitat for Wilson's Storm Petrels is very limited, Turmoil Point and Fryer Point being the most likely sites, with a single bird seen hovering and possibly landing at the latter.
Blue-eyed Shags were recorded in two colonies on the north-west coast, one of 30 pairs on a small islet close offshore and lying approximately 3km from Turmoil Point, the other of 18 pairs on the rock headland at Fryer Point. A third colony probably exists on the rock headland west of Harker Point, where birds were seen in 1930 (Kemp and Nelson 1931) and also in 1964 when a breeding colony of about 100 birds was recorded (Holdgate and Baker 1979). During the current survey a resting area was recorded close west of Fryer Point. The total island population may be in the region of 80 pairs.

Brown Skuas were seen in the vicinity of the small Chinstrap colony on the north-west coast, and it is possible that 1 or 2 pairs breed here. No Dominican Gulls were seen.

**Navigation**

Between Turmoil Point and Fryer Point lies an extensive offshore plateau of 20m depth, dotted with numerous submerged rock pinnacles that break in slight seas. On the east side of Fryer Point is a plateau of 8m of water with at least 2 submerged rocks lying 200m offshore, over which seas break. It is possible for a boat to anchor between these breakers and the shore in west to south winds and calm seas.

From Turmoil Point, a submerged reef extends 1.5km south-west to Grindle Rock. Depths over the reef are probably less than 5m and numerous breakers were visible in calm seas. In good weather there is a boat passage over the reef, with a minimum recorded depth of 4m between breakers when passing from north to south and approximately 100m off Turmoil Point. An apparently deep water passage exists between Grindle Rock and nearby Wilson Rock. This latter islet appears to be clear of danger with minimum depths of 15m recorded just 20m offshore. Freezland Rock, lying 4km south-west of Turmoil Point, is surrounded by a shallow plateau of both submerged and visible low rocks which break in slight seas and extend up to 100m offshore. Inshore circumnavigation of the islet is hazardous.

**Freezland Rock**

Slightly larger than Leskov Island in surface area (40ha compared to 30ha) and coastline length (2.7km compared to 2.5km), this ice-free islet lies 4km south-west of Bristol Island and rises to an altitude of 305m (Fig. 12). It is spectacularly sheer.

Kemp and Nelson (1931) and Holdgate and Baker (1979) record Chinstrap Penguins as being abundant, with a few Macaroni Penguins also being seen. In this survey, 7500 pairs of Chinstraps were estimated to nest at four sites on the islet, with a number of Adelies seen in the colony at the south-west point.

1200 pairs of Antarctic Fulmars were counted on the cliffs, and 100 on a rock close off the south-east point. 9 pairs of Snow Petrels and 76 pairs of Cape Petrels were seen scattered along the cliffs.

There are two areas of extensive scree which appear to be ideal for Wilson's Storm Petrels, although no birds were seen.

Blue-eyed Shags were seen in a resting area on a rock close off the south-east point, but not nesting.

Two Dominican Gulls and a single Sheathbill (the only bird of this species recorded during the survey), were seen in the Antarctic Fulmar colony on a rock close of the south-east point. Brown Skuas, recorded in 1964, were not seen in this survey.
**Wilson Rock**

Wilson Rock lying 1.5km east of Freezland Rock, is only slightly smaller in surface area (25ha) and coastline length (2.4km). It is also ice-free and rises to nearly 200m altitude (Fig. 12).

As in 1964 (Holdgate and Baker 1979), Chinstrap Penguins were seen resting on the south point coast but no sign of breeding was observed.

7000 pairs on Antarctic Fulmars were estimated to nest on the sheer cliffs, with about 100 pairs of Cape Petrels and around 10 pairs of Snow Petrels.

There are several scree slopes on the islet, and Wilson's Storm Petrels were seen landing at the south point area, indicating probable breeding.

**Grindle Rock**

Separated from the mainland coast of Bristol Island by a 1.5km long reef, Grindle Rock is roughly the same size as Wilson Rock. It is ice-free and is just over 200m high (Fig. 12).

7000 pairs of Chinstraps were recorded at 4 sites on the east coast.

5000 pairs of Antarctic Fulmars were nesting in loose colonies on the cliffs, with about 60 pairs of Cape Petrels and 10 pairs of Snow Petrels among them.

A large boulder scree slope at the south end of the islet provides ideal habitat for Wilson's Storm Petrels, and several birds were seen hovering over these slopes.

No Dominican Gulls or Brown Skuas were seen.

**Montagu Island**

This is the largest and highest island in the South Sandwich Islands group. Covering 11 000 ha, it is nearly 2.5 times the size of Bristol Island, the second largest island of the group (Fig. 6). It is heavily glaciated and rises to 1372m at Mt Belinda, with no signs of recent volcanic activity. In contrast to most of the other islands in the group, Montagu Island has a number of offshore stacks and islets, some of which are up to 100m in length, and of which five have small breeding populations of Blue-eyed Shags, Cape Petrels, Antarctic Fulmars and Chinstrap Penguins.

Approximately 100ha of the island's 400ha of ice-free ground consist of rock headland areas, principally at Scarlett Point and Allen Point. There are large colonies of Chinstraps at both sites, with 3000 pairs at Scarlett Point and 16 000 at Allen Point. The remaining 800 pairs of the island's total Chinstrap population (estimated at 20 000 pairs) were recorded at Mathias Point and on an offshore islet midway along the north coast.

No Adelie, Gentoo or Macaroni Penguins were seen during this survey but a closer inspection is necessary to confirm these species breeding status. In 1957, Adelies were recorded at possibly Allen Point (Ivanov in Holdgate and Baker 1979). None were seen here in March 1964 (Holdgate and Baker 1979). At this time, 2 pairs of Macaroni Penguins were seen at Horsburgh Point among a small Chinstrap colony, but neither species was seen here in this survey.

Approximately half of the island's 47km coastline consists exposed rock, of which 14km are steep cliffs favoured by Antarctic Fulmars. Their total population was estimated to be 20 000 pairs, the second-largest in the South Sandwich Islands group. Cape Petrels and Snow Petrels were also abundant. The former species' population was estimated to be 1500 pairs, the latter 400 pairs.
Along the north coast between Leeson Point and Borley Point, where the cliffs rise to 400m altitude, an estimated 2,300 pairs of Antarctic Fulmars were seen nesting, with a few Snow Petrels, while Cape Petrels were found only on the offshore stacks. Approximately half of the island's total population of Antarctic Fulmars, in addition to about 500 pairs of Cape Petrels and 100 Snow Petrels, were seen on the 4km section of cliff between Allen Point and Mathias Point on the east coast. The exceptional abundance of Antarctic Fulmars at this site has been noted by previous expeditions (Holdgate and Baker 1979). The west and south-west coast cliffs between Borley Point and Allen Point are also excellent nesting sites for Antarctic Fulmars with 6000 pairs being estimated at about 6 different sites, concentrated mainly at Hollow Point (1700 pairs), Horsburgh Point (900 pairs), Scarlett Point (800 pairs) and Allen Point (2500 pairs). Most of these sites also had numerous Cape Petrels, with 600 pairs at Borley Point and 100 at Horsburgh Point; and to a lesser extent Snow Petrels, mainly at Borley Point where 100 pairs were seen.

Four colonies of Blue-eyed Shags, totalling 185 breeding pairs, were recorded during this survey. 110 pairs were seen close north of Mathias Point in the vicinity of a small Chinstrap colony which was also noted in 1964 (Holdgate and Baker 1979); and another 30 pairs at Horsburgh Point. The remaining 2 colonies were both on offshore stacks on the island's north coast, one with 30 pairs, the other with 15. In 1964, no shags were recorded at Horsburgh Point. Instead, a small Chinstrap colony and 2 pairs of Macaroni Penguins were seen (Holdgate and Baker 1979), but neither was recorded here during the current survey.

No Brown Skuas, Dominican Gulls or Wilson's Storm Petrels were seen, but it is possible that these species breed in the vicinity of the large Chinstrap colonies at Allen Point.

Navigation
During the course of the survey, the island was circumnavigated at approximately 100m offshore, passing inside most of the offshore rocks and islets, with the exception of the reefs lying off Leeson Point and Scarlett Point. The only area that was obviously foul was Phyllis Bay, where a plateau of submerged rocks extends up to 1nm (2km) east of Scarlett Point. Otherwise, there appear to be few submerged rock pinnacles, despite the number of visible offshore stacks.

In north-west winds, it is possible for a small vessel to find shelter in Phyllis Bay on the shoal plateau close off Scarlett Point. On the east coast immediately north of the ice-free area at Mathias Point, the ice-cliffs have retreated to form a small indentation not shown on Admiralty Chart 3593. Shelter can also be found here in a south-west wind.

Saunders Island
Saunders Island is one of the largest islands in the group, ranking with Cook, Bristol and Visokoi Islands in terms of size (Fig. 7). Similarly, it is also heavily glaciated, with approximately 70% of its 3,000ha being covered in ice. At the time of the survey, the volcano on Mount Michael (991m high) was very active, and coloured vapour was seen emanating continuously from the full width of the crater.

17km of the island’s total 26km coastline is ice-free and consists of 5m to 10m high lava cliffs interspersed here and there with gullies of loose ash. There is a 6km long narrow beach of loose ash in Cordelia Bay, offering some of the best habitat for elephant seals in the South Sandwich Islands.

There are approximately 700ha of ice-free ground at Blackstone Plain and Ashen Hills. Nearly 60% of the island’s estimated 100,000 pairs of Chinstrap Penguins nest at the latter site in half a dozen or so distinct groups on the north-facing slopes between Nattriss Point and the ice-cap 3km to the west. Some Adelie Penguins were also seen here. Another 2 Chinstrap colonies of 5200 pairs were seen on the south-facing slopes about 3km south-west of Nattriss Point. About 15,000 pairs Chinstraps and a few Adelies nested at Yellowstone Crag and close east of Harper.
Point on Blackstone Plain. 26000 pairs of Chinstraps breed on the west coast, and the Ollivant Point and Carey Point colonies are unusual in that they spill over on to ash-covered glaciers. From the boat, it was not possible to estimate the number of Adelies, but it is not likely to be more than a few thousand pairs.

No Macaroni or Gentoo Penguins were seen during the survey, but both species were seen in 1964 and were suspected to nest in small numbers, the former at both Blackstone Plain and Ashen Hills, and the latter on the lower slopes of the Ashen Hills (Holdgate and Baker 1979).

Southern Giant Petrels were seen on the land in the Cordelia Bay area in 1964 (Holdgate and Baker 1979), and while no birds were seen during the present survey, there is ample suitable nesting habitat, especially at Blackstone Plain, and a landing would be necessary to confirm the presence of this species.

The low numbers of Antarctic Fulmars and Snow Petrels reflect the absence of suitable high cliff habitat. A single Antarctic Fulmar's nest was seen at Nattriss Point, although it is possible that a few more pairs may nest inland at Yellowstone Crags. The low lava cliffs, however, provide ideal habitat for Cape Petrels, and over 1163 pairs were counted, nearly all of which were along the north and south coasts of the Ashen Hills area. The total island population was estimated to be 1200 pairs. Only 5 Snow Petrel nests were seen, near Nattriss Point, but there may be more pairs nesting at the Yellowstone Crags.

There is extensive nesting habitat for Wilson's Storm Petrels at Blackstone Plain and Ashen Hills, and although not seen in this survey, several thousand pairs of this species probably nest on the island.

Brown Skuas and Dominican Gulls were seen in the Chinstrap colony at Ollivant Point, probably breeding, and there are undoubtedly additional pairs in the Nattriss Point area.

No birds were seen nesting on the offshore rocks and stacks of Brothers Rocks.

Navigation
During the course of a circumnavigation of the island, at between 20m and 500m from the coast, no isolated submerged rocks were seen and depths were generally constant between 20m and 50m. A few submerged rocks lie close off Harper Point. Several submerged rocks, over which the sea broke heavily in calm conditions, were seen off Sombre Point. The area between the point and Brothers Rocks appeared to be foul, but an inshore passage with a minimum depth of 5m was found close off Sombre Point.

The route from Sombre Point to Nattriss Bay appear to be free of dangers, and Cordelia Bay may offer shelter in westerly winds although it may be necessary to anchor close to the beach in order to find correct depths. An area indicated foul on Admiralty Chart 3593 and situated 1nm (2km) north of Nattriss Point, may extend north to Brothers Rocks, but between here and the Cordelia Bay coast there appear to be no dangers.

Close west of Nattriss Point is a 5m high islet separated from the coast by a narrow shallow channel with a maximum recorded depth of 3m, and not 5.5m as indicated on Admiralty Chart 3593.

Vindication Island
This is the second smallest island in the group and its 300ha are virtually ice-free, although a remnant ice cap persists above 350m altitude in the Quadrant Peak area. Most of the island's 7.5km coastline consists of high steep cliffs which rise precipitously on the west coast above Knob Point to the island's summit, the 426m high Quadrant Peak (Fig. 8).
These cliffs effectively prevent access to the interior of the island, except at Chinstrap Point where a gully called Pothole Gulch, descends from the interior and permits the passage of Chinstraps to and from the large colony of 45,000 pairs, situated about 100m above sea level atop the coastal cliffs, and extending up to 500m inland and 1km along the coast north-east of the point. This is the only large Chinstrap Penguin colony on Vindication Island. A small group of 200 pairs was also seen 600m east of Chinstrap Point, at the foot of the 100m high cliffs. 100-200 Macaroni penguins were seen here in March 1964 (Holdgate and Baker 1979), but a landing would have been necessary to confirm breeding during the survey, as none were seen from the boat.

The coastal cliffs provide ideal habitat for Antarctic Fulmars. Approximately 1900 pairs were counted on Vindication Island, of which 50% were recorded on the south-west coast cliffs between Knob Point and Chinstrap Point. Another 200 pairs were seen on Cook Rock, and a few on Saw Rock, giving an estimated total of 2200 pairs.

A total of 700 pairs of Cape Petrels were estimated, with 50 pairs close east of Knob Point, 450 pairs at Crosscut Point, 100 pairs on the islet lying close off this point, 50 pairs on Cook Rock, and a few on Saw Rock.

Very few Snow Petrels were seen, with less than 10 nests recorded. Despite the appearance of an abundance of suitable nesting sites along the cliffs, birds were surprisingly scarce. It is possible that nest-sites are not easily seen from the boat due to the steepness of the cliffs. The total population was estimated to be 100 pairs.

A few Blue-eyed Shags were seen resting on a rock close west of Trouser's Rock. Wilson's Storm Petrels, Dominican Gulls and Brown Skuas were seen in 1964 (Holdgate and Baker 1979) and although none were seen during the present survey, these three species are probably breeding.

No birds were seen on Castor, Pollux, Buddha, Trouser's or Santa Rocks.

Navigation

Vindication Island lies within the 100m depth line that also includes Candlemas Island, 5km to the east. Nelson Channel, with its numerous islets, rocks and submerged reefs, separates the two islands, and as remarked by Holdgate and Baker (1979), these rocks extend farther from the shore than is usual in the South Sandwich Islands group.

In a south-westerly, good shelter can be found on the north-east coast in 10m depth of water, while on the south-east coast is an anchorage with 8m depth, protected from north-westerly winds, with the Braces Point reef affording some protection from swell. This reef extends up to 1nm (2km) north-east of Braces Point and consists mainly of submerged rocks over which the sea breaks heavily. Braces Point consists of a 200m long spit which is probably awash when a big sea is running. Two conspicuous islets, Trouser's Rock (15m height) and Cook Rock (46m height) lie about 600m north-east of the point and another 2m high rock lies 700m north-east of these, with a more or less continuous line of shoals connecting them. No boat passage appears to exist across this reef.

There is a dinghy passage only between the coast and Pollux and Castor Rocks. A submerged reef extends west from Knob Point to Buddha Rock, but to seaward close off this rock, depths of over 20m were recorded. Generally, there appeared to be no dangers when passing 100m offshore around the island.
Candlemas Island

Candlemas Island occupies 950ha, of which 575ha are ice-free (Fig. 9). Nearly all of its 15km coastline is also ice-free, with the exception of approximately 1km on the south and east coasts where 4 small glaciers descend to sea level. The north-west half of the island is entirely ice-free, and showed constant signs of volcanic activity in the Lucifer Hill area. The island’s southern half appeared to be dormant and ice-covered, with summits of over 500m height.

There are 375ha of level or undulating ice-free ground that provides excellent breeding habitat for penguins, with the largest colonies being situated between Carbon Point and Clapmatch Point, and on the plain around Gorgon Pool from Demon Point to Chimaera Flats. Due to the nature of the terrain, Candlemas Island proved to be one of the most difficult islands to survey by boat. This was due to the fact that the colonies were only partially visible from the sea, being positioned atop and behind the 10m to 15m high lava cliffs along the west and north coasts, on level lava plateaux that extended up to 1km inland.

A British Antarctic Survey geological field party was camped on Candlemas Island at the time of the survey, and BAS field assistant, Ash Morton, was able to map and accurately count the island’s penguin population (pers. comm. A. Morton). A comparison of population estimates shows that the boat survey estimate of 149,000 pairs of Chinstraps compared favourably with the 143,153 pairs counted by A. Morton.

There were of course, differences between individual colony counts: at the Carbon Point-Clapmatch Point colony the boat count overestimated the shore count by 50%, at the Gorgon Pool colony the boat count underestimated by 50%. In both instances this was due to the difficult of viewing the terrain from the boat. At Shrove Point, the shore count underestimated by 50% because at least one half of the colony was not visible, again due to the nature of the terrain. However, it is interesting to note that despite these differences, both surveys’ total population estimates even out at around 150,000 pairs.

Macaroni, Gentoo and Adelie Penguins were recorded breeding on the island in 1964 (Holdgate and Baker 1979) and again in 1997, when 1,128 pairs of Macaronis, 190 pairs of Gentoos and 930 pairs of Adelies were counted (pers. comm. A. Morton). None of these were visible from the boat.

1,516 pairs of Southern Giant Petrels nested on the Breakbones Plateau (pers. comm. A. Morton). From the boat it was possible to see birds taking off and landing in this area.

While a boat survey of the seabird populations nesting on the level plains was limited by the topography, there were no such difficulties when counting coastal cliff-nesting species. 1,134 pairs of Cape Petrels were counted and the island’s total population estimated to be 1,500 pairs. The majority of these nests (280) were seen on the 10m to 15m high lava cliffs along the coast between Vulcan Point and Kraken Cove, and 342 on the east coast between Boot Rock and Shrove Point. Another 500 pairs were estimated to breed on the north-facing slopes above Chimaera Plain, with an estimated 500 pairs of Antarctic Fulmars on the steeper slopes above, and approximately 500 pairs of Snow Petrels.

From the boat, Wilson’s Storm Petrels were seen flying above Boot Rock. Thousands were estimated to nest on Candlemas Island, and also some Black-bellied Storm Petrels (pers. comm. A. Morton).

No Brown Skuas or Dominican Gulls were seen from the boat. However, both species were confirmed breeding, with 340 pairs of the former and 14 pairs of the latter (pers. comm. A. Morton).

Navigation
The coast between Sea Serpent Cove and Carbon Point appears to be free of danger. However, the average depth recorded when approximately 300m from the shore along this coast was 10m
shelving gently to the shore but with no visible shoals or rocks. The south and east coasts from Clapmatch Point to Boot Rock were also clear of danger and with deep water close inshore. North of Boot Rock depths shallowed to less than 10m when passing between Tomblin Rock and the coast, and although no breakers were seen, this area is probably foul. There appears to be a plateau of less than 10m depth extending up to 500m offshore on all sides Demon Point.

Kraken Cove is a good anchorage in south to south-west winds, with depths of approximately 10m up to 1km from the beach. The west side of the bay is foul, as indicated on Admiralty Chart 3593. Gorgon Pool is barred from the sea by a 3.5m high boulder spit.

15m high lava cliffs extend from Kraken Cove west to Vulcan Point and Tow Bay. Depths of 15m to 20m and less were recorded when passing 50m to 100m offshore, and no offshore breakers were seen.

Depths in Sea Serpent Cove were less than indicated on Admiralty Chart 3593, being generally 5m or less and it would appear that the cove has shallowed considerably since the 1964 survey. This cove would offer good shelter for small vessels in an easterly gale.

In suitable conditions, landings are possible on the boulder beachers at Sea Serpent Cove, Tow Bay, Kraken Cove and Clinker Gulch. Each of these boulder beaches forms a 3m to 5m high barrier between inland pools and the sea. It is possible that volcanic activity or prolonged wave action may periodically open these barriers to the sea, but during this survey, none of the pools were accessible by dinghy from the sea.

In 1964, Gorgon Pool was also closed to the sea by a spit (Holdgate and Baker 1979). However, it is possible that in 1908, when C.A. Larsen and a party from the vessel Undine landed on the island's east coast, the shoreline was considerably different. Holdgate and Baker (1979) speculated that at the time of Larsen's visit, the boulder spit that separates Gorgon Pool from Kraken Cove did not exist, and that the pool was in fact open to the sea. Possibly in 1908 the reef of sunken rocks and breakers (over which Larsen recorded a minimum depth of 5 fathoms) that fringed the bay where Larsen landed, corresponded with the position of today's boulder spit. Inside this reef, a safe landing was effected in what today is Gorgon Pool, and which Larsen qualified as an excellent harbour for boats. Demon Point itself is not recognisable on Larsen's 1908 sketch map, although it was described as the southern point of the island running out in the sea as "a low tongue of land, where thousands of penguins dwell." (Larsen 1908). By 1930, when Discovery II visited, this low tongue had become a narrow bifed structure (Kemp and Nelson 1931), rather than the rounded point that was charted in 1964 and which still exists today.

Similarly on the west coast at Sea Serpent Cove, the opening in the spit to Medusa Pool that was mapped in 1964 (Holdgate and Baker 1979), today no longer exists. Instead, a continuous boulder beach about 3m to 5m high links Sarcophagus Point to the south side of the cove, possibly in much the same way that the Discovery II team found it in 1930 when the pool was also closed to the sea. Such changes in topography, no doubt due to volcanic activity, mean that coastline descriptions and charts of Candlemas Island should be read with caution.

Visokoi Island

This is the third-largest island in the South Sandwich Island group (Fig. 10). Its 2750ha are heavily glaciated, and rise steeply to a summit crater at Mt Hudson of 1006m altitude, which did not appear to be active. This icecap descends to sea level here and there around the coast but precipitous ice-free cliffs extend along 16km of the total 22km of coastline. There are 750ha of ice-free ground of which 120ha are rock headland-type terrain, mainly at Irving Point, Finger Point, Mikhaylov Point and a small ridge to the north-west of Saddle Bluff.

The total population of Chinstrap Penguins was estimated at 96,000 pairs, with 15,000 at Finger Point, 5600 at Mikhaylov Point, 75,000 along 2km of coast extending west from Irving Point,
and a small group of 35 pairs on a steep rock slope 2km north of Irving Point. It was not possible to confirm the presence of other species of penguins. 200 Gentoos were seen adjacent to the Chinstrap colony at Irving Point in March 1964, and several hundred Macaroni Penguins were recorded at both Irving Point and Finger Point among the Chinstraps (Holdgate and Baker 1979).

The island's coastal cliffs offer ideal habitat for Antarctic Fulmars and a total population of over 25 000 pairs was estimated. This is the largest concentration of Antarctic Fulmars in the South Sandwich Islands group. 80% of the population nested on the west and south coasts between Finger Point and Mikhaylov Point, but nest-sites were seen on virtually all coastal cliffs up to an altitude of approximately 350m altitude, and were often indicated by green moss patches growing in the shelter of guano-enriched crevices adjacent to nests.

Cape Petrels were also numerous with 1270 pairs counted, these being concentrated on the east and south coast cliffs. 250 pairs were recorded at Saddle Bluff and on the cliffs 1km to the north; 200 pairs nested 1km west of Irving Point; 520 pairs on the cliffs between Wordie Point and Mikhaylov Point; and 300 pairs on a headland 1km north of Wordie Point. Very few were seen along the north-west and north-east coasts. Surprisingly, only a few Snow Petrels were recorded (adjacent to Antarctic Fulmars on the east coast cliffs) but this species often nests in crevices at high altitudes and it is possible that nest-sites were not visible from the boat. The total population was estimated to be 100 pairs.

No Brown Skuas, Dominican Gulls, or Wilson’s Storm Petrels were seen, although there was suitable habitat for all three species. In 1964, 4 to 5 pairs of Brown Skuas were estimated to breed at Irving Point, and a few more at Finger Point; 4 to 5 pairs of Dominican Gulls were thought to nest at Irving Point (Holdgate and Baker 1979). 50 Antarctic Terns were seen at one site on the east coast cliffs, possibly nesting.

Navigation
Two rock pinnacles were seen off the south coast of Visokoi Island, up to 1nm east of the Mikhaylov Point and there is a very conspicuous rock pinnacle approximately 40m high on the south coast cliffs, 1km east of Mikhaylov Point. Depths along this coast remained at approximately 30m when 50m to 100m offshore. There are possibly submerged pinnacles on this plateau and caution is necessary when passing inshore.

Shallow depths were also recorded on the north-east coast in the vicinity of Coffin Rock, where a minimum depth of 4m was recorded when passing to seaward. A shallow plateau of undetermined extent appeared to stretch to seaward of this.

Zavodovski Island

Zavodovski Island is the northernmost island in the South Sandwich Islands group (Fig. 11). It is actively volcanic, with constant vapour emissions from a large central summit crater, and from a fissure on the south-west coast below Mt Curry where large yellow-coloured deposits were visible. 1100ha of its total 1400ha surface is ice-free, as is its entire 16km coastline.

The west coast cliffs from Noxious Bluff north to Pacific Point rise precipitously to 500m altitude at the island's summit on Mt Curry, (550 m high) where there are some snow fields. The north, east and south coasts consist of an extensive level plateau that rises gradually to the summit from a shoreline of 15m to 30m high cliffs, occasionally fringed with narrow boulder beaches or rock platforms. These cliffs are intersected by gulches which permit access to the interior.

Zavodovski Island has the largest Chinstrap colony in the South Sandwich Islands group. Often cited as “millions of penguins”, the island’s total population was estimated by this survey to be 750 000 pairs, or about 60% of the total South Sandwich Islands’ population. The main colony, estimated at 450 000 pairs, dominates the east coast plain from Fume Point to Pungent Point.
Another 285 000 pairs were estimated between Acrid Point and Reek Point, and 10 000 at Stench Point.

King Penguins were probably first seen on the island in 1830 (Brown in Holdgate and Baker 1979), and possibly recorded again in 1930 (Kemp and Nelson 1931) but breeding has only recently been confirmed (pers. comm. P. Prince). Adelie and Macaroni Penguins were reported breeding in 1957 (Ivanov in Holdgate and Baker 1979), and Gentoos were seen ashore in 1930 (Kemp and Nelson 1931). Due to bad weather conditions at the time of the survey, it was not possible to confirm the presence of these species, but from the composition of the penguin colonies of Candlemas and Thule Islands, it is not improbable that several hundred pairs of Adelies, Macarons and Gentoos could nest on Zavodovski Island.

Numerous Southern Giant Petrels were seen on the ground on the east coast at Pungent Point, inland from the Chinstrap colony, and breeding was confirmed by A. Morton (pers. comm.). Quite possibly the number of breeding pairs is at least equivalent to that of Candlemas Island, and may be between 1500 and 2000 pairs.

Despite the extensive length of apparently suitable cliff habitat, Cape Petrels were seen in very low numbers, at 5 sites: Pacific Point, Acrid Point, a stack close north of Pungent Point, on coastal cliffs midway between Reek Point and Pungent Point, and at Noxious Point. The total population was estimated to be 200 pairs.

No Antarctic Fulmars were seen, despite there being 12km of suitable habitat along the west coast cliffs. This area was subject to a considerable amount of volcanic activity, with constant vapour emissions and extensive yellow-coloured deposits that possibly prevent seabirds from occupying potential nest-sites.

Snow Petrels were seen nesting adjacent to Cape Petrels in gulleys about 20m above sea level along the cliffs at Pacific Point. It is unlikely that the total population exceeds 100 pairs.

Based on the abundance of suitable habitat, it is probable that several thousand Wilson's Storm Petrels nest on the island, and possibly also Dove Prions.

A colony of Blue-eyed Shags, estimated at 100 pairs, was seen in February 1987 (pers. comm. N. Cobley) on a rocky headland close south of Pungent Point.

Brown Skuas were seen in 1957 (Ivanov in Holdgate and Baker 1979), and it is probable that several hundred pairs nest in the vicinity of the Chinstrap colonies. Dominican Gulls were seen on the east coast between Reek Point and Pungent Point and probably breed here. Approximately 100 Antarctic Terns were seen flying above a stack close south of Reek Point, and possibly about 30 pairs were nesting here.

A more detailed survey of Zavodovski Island is necessary in order to census accurately the large Chinstrap colonies and to determine the breeding status and abundance of other species. This may have been carried out by a BAS geological field party in 1997 which was camped on the island at the time of the boat survey, but no details are available.

Navigation
Due to strong headwinds and high seas along the north coast, the survey circumnavigation was carried out at about 500m from the coast. At this distance offshore, depths remained constant at about 20m, except at Acrid Point and Stench Point, where depths shallowed to 9m although no breakers were seen. There is no shelter for small boats except in calm conditions, when it is possible to anchor off the east coast and to land on one of the small boulder beaches at the foot of the gulleys descending between the coastal cliffs.
Leskov Island lies 55km (30nm) to the west of the arc formed by the main islands of the South Sandwich Islands group. It is the smallest island in the group, being a 30ha ice-free rock and smaller in size than Freezland Rock (Fig. 12). Its 2.5km cliff coastline rises steeply from the sea to the 189m high summit.

Leskov Island was not surveyed by boat. However, a cursory inspection by helicopter on January 30, 1997 confirmed previous reports of the absence of penguins (pers. comm. N. Brothers). Extensive scree slopes were noted as being potentially suitable nesting habitat for Dove Prions. Cape Petrels were seen nesting on the cliffs. Snow Petrels and Antarctic Fulmars were not seen during this survey but were recorded in 1964 (Holdgate and Baker 1979), as were Brown Skuas and Wilson's Storm Petrels.
VIII. CONCLUSIONS

Survey Coverage

Favourable weather conditions allowed the majority of the survey's objectives to be achieved. 92% of the coastline of the South Sandwich Islands was surveyed, and also Clerke Rocks. Most of the survey was carried out from the boat as this was the most efficient and rapid method of examining the coastline. Landings were made only when the weather was unsuitable for boat surveys, and providing sea conditions permitted. However, for a preliminary survey such as this, emphasis was placed on obtaining maximum broad-scale coverage of each island, so that all locations received about the same degree of survey coverage, regardless of their ecological diversity.

Population estimates based on colony area and/or counts of occupied nests were made for virtually all colonies of Chinstrap Penguins, Antarctic Fulmars, Cape Petrels, Snow Petrels and Blue-eyed Shags. Estimates of other seabird populations, generally not easily visible from the boat, were based on available breeding habitat, on counts obtained during landings, and on information from previous expeditions. The Chinstrap Penguin population of the South Sandwich Islands, thought to be the largest concentration of this species in the world, was estimated to be 1,285,000 pairs, significantly less than the previous estimate of 5 million pairs, and probably less than that of the South Shetland Islands.

Logistic Considerations

The islands' exposed coasts and frequent bad weather render landings impossible at times. For this reason, it would not be possible to envisage a survey of all islands based only on shore counts. Even access using helicopters is limited, since not all seabird colonies are adjacent to a suitable landing site, and in places, Antarctic Fulmars (particularly sensitive to disturbance from helicopters) breed in such vast numbers as to pose a hazard to flying.

From previous expedition accounts, fog and low cloud are frequent at the islands and could impose days of delays to a seabird survey programme, regardless of whether logistical support is shore-based, boat-based or helicopter.

Snow on the ground also disadvantages seabird counts. Birds contrast conspicuously with the dark rock habitat but 'disappear' against a light covering of snow. This is an important consideration when planning future surveys. Although snow falls can occur in any month, there is less chance of snow remaining on the ground during mid to late summer i.e. January to March.

Survey timing should also coincide with species' breeding timetable. Early January would be ideal, as species are still brooding chicks and thus occupying nest-sites.

Future Surveys

Now that the overall seabird population abundance and distribution is known, future survey work is required at certain specific locations where there are exceptional concentrations of wildlife. A. Morton has surveyed in detail Candlemas Island, and possibly the second BAS field party present at the South Sandwich Islands in January and February 1997, has surveyed other sites, although no information was available at the time of writing.

Principal locations for future shore-based survey work are the large ice-free areas on the east coast of Zavodovski Island; the Chinstrap Point area on Vindication Island; all of Bellingshausen Island; Blackstone Plain and Ashen Hills on Saunders Island; Allen Point on Montagu Island; Irving Point on Visokoi Island. Besides being the locations of some of the
largest Chinstrap colonies in the islands, these sites contain populations of undetermined size of Gentoo, Adelie and Macaroni Penguins, Brown Skuas, Southern Giant Petrels, Dominican Gulls and Antarctic Terns, and Fur Seals, none of which can be surveyed in detail from a vessel.

Clarification is required of the breeding status of Dove Prions and Black-bellied Storm Petrels. More precise counts are required of the Fur Seal population, ideally censused between mid and late December when cows are hauled out for pupping.

More precise mapping and counting of penguin colonies is also required. Aerial photography with ground controls would be ideal.

Thule Island Argentine Station

Despite its probably minimal impact upon the fauna, the ruins of this station are undeniably ugly and environmentally alien. Any proposed 'clean-up' would have to take place during the summer months. A total clearing of the site would cause major disturbance to penguins, with unavoidable egg loss and chick mortality. Removal of loose materials and non-corrosive items could be considered as a first step. These are probably best air-lifted by a helicopter operating as late as possible in the summer season in order to minimise disturbance to wildlife. The installation of temporary wire exclusion mesh fences to exclude penguins from certain areas, such as a pedestrian walkway from the landingbeach to the work site if boats are used, should be considered.

ACKNOWLEDGEMENTS

I would like to thank Mr. Craig Shelton, former Assistant Commissioner for the Government of South Georgia and the South Sandwich Islands, for his encouragement during the planning of this survey; Mr Russell Jarvis, the incumbent Assistant Commissioner, for his continued support during the writing of the report; the captains and crew of HMS Endurance and RRS James Clark Ross for their assistance during the survey; and survey assistants Nigel Brothers, Catherine Bone, Mary-Ann Lea and Rosy Whelan for their contribution to the collection of field data.

Special thanks go to Ash Morton for his generosity in sharing his field notes, and to Sally Poncet for her assistance in the preparation of this report.
<table>
<thead>
<tr>
<th>Date</th>
<th>Time GMT Start</th>
<th>Time GMT Finish</th>
<th>Nautical miles travelled</th>
<th>Weather Conditions</th>
<th>Locations and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1.97</td>
<td>0800</td>
<td>1800</td>
<td>5</td>
<td>W 10kt</td>
<td>Departed Bird Island for Elsehul.</td>
</tr>
<tr>
<td>16.1.97</td>
<td>1800</td>
<td>2200</td>
<td>43</td>
<td>NE 5kt</td>
<td>Departed Elsehul for Leith Harbour.</td>
</tr>
<tr>
<td>17.1.97</td>
<td>2200</td>
<td></td>
<td>20</td>
<td></td>
<td>Departed Leith Harbour for Grytviken.</td>
</tr>
<tr>
<td>18.1.97</td>
<td>0800</td>
<td>1100</td>
<td>12</td>
<td></td>
<td>At Grytviken.</td>
</tr>
<tr>
<td>19.1.97</td>
<td>1100</td>
<td>1300</td>
<td>20</td>
<td></td>
<td>At Grytviken.</td>
</tr>
<tr>
<td>20.1.97</td>
<td>1300</td>
<td>1800</td>
<td>45</td>
<td></td>
<td>Departed Grytviken for Gold Harbour.</td>
</tr>
<tr>
<td>22.1.97</td>
<td>2000</td>
<td>0800</td>
<td>43</td>
<td>W 15kt</td>
<td>Departed Larsen Harbour, South Georgia, and arrived Clerke Rocks. CLERKE ROCKS - circumnavigated and surveyed all islands and rocks. No landings. Excellent survey conditions.</td>
</tr>
<tr>
<td></td>
<td>0800</td>
<td>1100</td>
<td>12</td>
<td>NE 5kt</td>
<td>Departed Clerke Rocks for Thule I.</td>
</tr>
<tr>
<td>23.1.97</td>
<td>1100</td>
<td>1300</td>
<td>350</td>
<td>W 15kt</td>
<td>On passage</td>
</tr>
<tr>
<td>24.1.97</td>
<td>1300</td>
<td>1800</td>
<td>12</td>
<td>NW 15kt</td>
<td>On passage</td>
</tr>
<tr>
<td>25.1.97</td>
<td>0800</td>
<td>1100</td>
<td>4</td>
<td>NNW 20kt</td>
<td>THULE I.- arrived off Cape Flannery.</td>
</tr>
<tr>
<td></td>
<td>1100</td>
<td>1300</td>
<td>4</td>
<td>NNW 30kt</td>
<td>Surveyed S coast from Cape Flannery to Ferguson Bay. 50m-100m offshore in initially excellent surveying conditions, the lee of the land providing shelter from the gale.</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1800</td>
<td>4</td>
<td>NW 40kt</td>
<td>Survey stopped by gale at Ferguson Bay. At anchor in Ferguson Bay.</td>
</tr>
<tr>
<td></td>
<td>1800</td>
<td></td>
<td>12</td>
<td>NW 20kt</td>
<td>Landed in small rollers at Hewison Pt in Ferguson Bay to carry out shore counts. Visited Argentine station ruins and BAS seismic party.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>overcast, rain</td>
<td>Survey stopped by gale. Re-anchored on E side of Ferguson Bay.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>moderate sea, increasing</td>
<td>Overnight at Ferguson Bay anchorage.</td>
</tr>
</tbody>
</table>

Table 1. Survey Operations Diary
<table>
<thead>
<tr>
<th>Date</th>
<th>Time GMT Start</th>
<th>Time GMT Finish</th>
<th>Nautical miles travelled</th>
<th>Weather Conditions</th>
<th>Locations and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.1.97</td>
<td>0600</td>
<td>0900</td>
<td>5</td>
<td>SW 45kt</td>
<td>Departed Ferguson Bay for Beach Pt on E coast.</td>
</tr>
<tr>
<td></td>
<td>0900</td>
<td>1700</td>
<td></td>
<td>good vis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1700</td>
<td>2000</td>
<td></td>
<td>SW 25kt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2200</td>
<td>5</td>
<td>SW 10kt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2200</td>
<td>2330</td>
<td></td>
<td>good vis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2330</td>
<td>0700</td>
<td></td>
<td>SW 15kt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0700</td>
<td>1130</td>
<td>12</td>
<td>clear sky</td>
<td>Returned to THULE I to survey N coast from Beach Pt to Morrell Pt, returning to Beach Pt anchorage after dark. Survey hindered by low light levels which made cliff-nesting petrels difficult to see at Morrell Pt. Coast between Morrell Pt and Cape Hannery not surveyed.</td>
</tr>
<tr>
<td></td>
<td>1130</td>
<td>1200</td>
<td></td>
<td>calm sea</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>1500</td>
<td>3</td>
<td>W 10kt</td>
<td>BELLINGSHAUSEN I - circumnavigated clockwise from Isaacson Pt, surveyed 50m-100m offshore, hindered intermittently by fog patches. No landings possible due to swell.</td>
</tr>
<tr>
<td></td>
<td>1500</td>
<td>1830</td>
<td>27</td>
<td>fog increasing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1830</td>
<td>2030</td>
<td>4</td>
<td>W 10kt</td>
<td>BRISTOL I - Freezland, Wilson and Grindle Rocks off W coast of Bristol I, surveyed 50m offshore in good survey conditions.</td>
</tr>
<tr>
<td></td>
<td>2030</td>
<td>2230</td>
<td>5</td>
<td>good vis</td>
<td>Surveyed NW coast of Bristol I from Turnoil Pt to Fryer Pt, 50m-800m offshore. Reasonable survey conditions until hindered by fog at Fryer Pt. Anchored on E side of Fryer Pt.</td>
</tr>
<tr>
<td></td>
<td>2230</td>
<td></td>
<td></td>
<td>increasing to 15kt</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. continued
<table>
<thead>
<tr>
<th>Date</th>
<th>Time GMT Start</th>
<th>Nautical miles travelled</th>
<th>Weather Conditions</th>
<th>Locations and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.1.97</td>
<td>0600</td>
<td>5</td>
<td>calm</td>
<td>BRISTOL I - the E coast, viewed from the anchorage, appeared to have little suitable seabird habitat. Re-surveyed NW coast from Fryer Pt to Turmoil Pt in good conditions. S coast not surveyed.</td>
</tr>
<tr>
<td></td>
<td>0800</td>
<td></td>
<td>overcast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1500</td>
<td>34</td>
<td>S 5kt</td>
<td>On passage from Bristol I to Montagu I.</td>
</tr>
<tr>
<td></td>
<td>1800</td>
<td>7</td>
<td>increasing to 10kt</td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td>1900</td>
<td>20</td>
<td>calm sea, sunny</td>
<td></td>
</tr>
<tr>
<td>1900</td>
<td>2300</td>
<td>42</td>
<td>calm clear skies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29.1.97</td>
<td>0730</td>
<td>16</td>
<td>E 5-10kt</td>
<td>SAUNDERS I - arrived off Nattriss Pt.</td>
</tr>
<tr>
<td></td>
<td>1130</td>
<td></td>
<td>calm sea</td>
<td>Circumnavigated clockwise from Nattriss Pt, surveyed 20m-500m offshore in excellent conditions.</td>
</tr>
<tr>
<td></td>
<td>1830</td>
<td>43</td>
<td>overcast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2100</td>
<td>5</td>
<td>W 5kt</td>
<td>On passage from Saunders I to Vindication I.</td>
</tr>
<tr>
<td></td>
<td>2100</td>
<td>2</td>
<td>clear, sunny</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2200</td>
<td>7</td>
<td>W 5kt</td>
<td>VINDICATION I - circumnavigated clockwise from Cook Rock, including Saw, Buddha, Castor, Pollux, Santa and Trouser's Rocks, in excellent survey conditions.</td>
</tr>
<tr>
<td></td>
<td>2200</td>
<td></td>
<td>good vis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2330</td>
<td></td>
<td>clear skies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>calm sea</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. continued
<table>
<thead>
<tr>
<th>Date</th>
<th>Time GMT</th>
<th>Nautical miles travelled</th>
<th>Weather Conditions</th>
<th>Locations and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.1.97</td>
<td>0600</td>
<td>0800</td>
<td>S 10kt</td>
<td>CANDLEMAS I. - landed at Kraken Cove with rollers on the beach. Visited BAS field party. Surveyed N coast from Kraken Cove to Tow Bay.</td>
</tr>
<tr>
<td></td>
<td>0800</td>
<td>0900</td>
<td>3 SE 5-10kt sunny</td>
<td>On passage from Candlemas I to Visokoi I.</td>
</tr>
<tr>
<td></td>
<td>0900</td>
<td>1300</td>
<td>24 SE 10-15 kt sunny</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1600</td>
<td>14 E 10-15 kt good vis slight sea</td>
<td>VISOKOI I. - circumnavigated clockwise from Mikhaylov Pt in excellent survey conditions.</td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>2000</td>
<td>30 NE 25-35kt sea increasing</td>
<td>On passage from Visokoi I to Zavodovski I.</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2300</td>
<td>10 NE 25-35kt good vis rough sea</td>
<td>ZAVODOVSKI I. - circumnavigated anticlockwise from Fume Pt, 500m offshore, in difficult survey conditions due to swell and strong winds with decreasing visibility due to darkness from Stench Pt to Fume Pt. Departed Zavodovski I for South Georgia.</td>
</tr>
<tr>
<td></td>
<td>2300</td>
<td>335</td>
<td>NE 50kt high sea</td>
<td></td>
</tr>
<tr>
<td>31.1.97</td>
<td></td>
<td>NE 45kt</td>
<td>SSW 35kt</td>
<td>On passage</td>
</tr>
<tr>
<td>1.2.97</td>
<td></td>
<td>0900</td>
<td>Arrived Grytviken</td>
<td>On passage</td>
</tr>
<tr>
<td>2.2.97</td>
<td></td>
<td>20</td>
<td>Departed Grytviken for Leith Harbour</td>
<td></td>
</tr>
<tr>
<td>3.2.97</td>
<td></td>
<td>75</td>
<td>Leith Harbour</td>
<td></td>
</tr>
<tr>
<td>4.2.97</td>
<td></td>
<td>20</td>
<td>Leith Harbour</td>
<td></td>
</tr>
<tr>
<td>5.2.97</td>
<td></td>
<td>75</td>
<td>Departed Leith Harbour for Bird Island</td>
<td></td>
</tr>
<tr>
<td>6.2.97</td>
<td></td>
<td>75</td>
<td>Departed Bird Island for Falkland Islands</td>
<td></td>
</tr>
<tr>
<td>7.2.97</td>
<td>0100</td>
<td>80</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>8.2.97</td>
<td></td>
<td>80</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>9.2.97</td>
<td></td>
<td>80</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>10.2.97</td>
<td></td>
<td>100</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>11.2.97</td>
<td></td>
<td>100</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>12.2.97</td>
<td></td>
<td>95</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>13.2.97</td>
<td></td>
<td>120</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>14.2.97</td>
<td></td>
<td>110</td>
<td>On passage</td>
<td></td>
</tr>
<tr>
<td>15.2.97</td>
<td>1600</td>
<td>150</td>
<td>Arrived Stanley, Falkland Islands</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. continued
<table>
<thead>
<tr>
<th>Date</th>
<th>Time GMT</th>
<th>Surveying</th>
<th>On passage</th>
<th>Number of Hours Weather-bound</th>
<th>Overnight</th>
<th>Total</th>
<th>Distance travelled (kilometres)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>On passage</td>
</tr>
<tr>
<td>25.1.97</td>
<td>0800-0600</td>
<td>8</td>
<td>0</td>
<td>6</td>
<td>8</td>
<td>22</td>
<td>0</td>
</tr>
<tr>
<td>26.1.97</td>
<td>0600-0600</td>
<td>6.5</td>
<td>3</td>
<td>8</td>
<td>6.5</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>27.1.97</td>
<td>0600-0600</td>
<td>11.5</td>
<td>4</td>
<td>8.5</td>
<td>24</td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>28.1.97</td>
<td>0600-0600</td>
<td>9</td>
<td>15</td>
<td>0</td>
<td>24</td>
<td></td>
<td>74</td>
</tr>
<tr>
<td>29.1.97</td>
<td>0600-0600</td>
<td>8</td>
<td>9.5</td>
<td>6.5</td>
<td>24</td>
<td></td>
<td>150</td>
</tr>
<tr>
<td>30.1.97</td>
<td>0600-2300</td>
<td>9</td>
<td>8</td>
<td>0</td>
<td>17</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>52</td>
<td>39.5</td>
<td>14</td>
<td>29.5</td>
<td>135</td>
<td>396</td>
</tr>
</tbody>
</table>

Table 2. An analysis of survey time and distance travelled at the South Sandwich Islands
<table>
<thead>
<tr>
<th>Seabirds</th>
<th>Number of Breeding Pairs</th>
<th>pre-1997 estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>King Penguin</td>
<td>a few</td>
<td></td>
</tr>
<tr>
<td>Gentoo Penguin</td>
<td>2500</td>
<td>5000</td>
</tr>
<tr>
<td>Adelie Penguin</td>
<td>8000</td>
<td>15 000</td>
</tr>
<tr>
<td>Chinstrap Penguin</td>
<td>1 250 000</td>
<td>1 750 000</td>
</tr>
<tr>
<td>Macaroni Penguin</td>
<td>2000</td>
<td>5000</td>
</tr>
<tr>
<td>Southern Giant Petrel</td>
<td>2000</td>
<td>4000</td>
</tr>
<tr>
<td>Antarctic Fulmar</td>
<td>70 000</td>
<td>110 000</td>
</tr>
<tr>
<td>Cape Petrel</td>
<td>8000</td>
<td>11 000</td>
</tr>
<tr>
<td>Snow Petrel</td>
<td>3500</td>
<td>5000</td>
</tr>
<tr>
<td>Dove Prion</td>
<td>100s</td>
<td>low 1000s</td>
</tr>
<tr>
<td>Wilson's Storm Petrel</td>
<td>low1000s</td>
<td>high 1000s</td>
</tr>
<tr>
<td>Black-bellied Storm Petrel</td>
<td>low100s</td>
<td>high 100s</td>
</tr>
<tr>
<td>Blue-eyed Shag</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Brown Skua</td>
<td>700</td>
<td>2000</td>
</tr>
<tr>
<td>Dominican Gull</td>
<td>80</td>
<td>200</td>
</tr>
<tr>
<td>Antarctic Tern</td>
<td>50</td>
<td>200</td>
</tr>
</tbody>
</table>

Status and Conservation of the World's Seabirds.

Table 3. Total estimated seabird population at the South Sandwich Islands
<table>
<thead>
<tr>
<th>SEABIRDS</th>
<th>Thule</th>
<th>Cook</th>
<th>Bellingshausen</th>
<th>Bristol</th>
<th>Montagu</th>
<th>Saunders</th>
<th>Vindication</th>
<th>Candiesias</th>
<th>Visokoi</th>
<th>Zevadorski</th>
<th>Laskov</th>
<th>Freezland Rock</th>
<th>Wilson Rock</th>
<th>Grindle Rock</th>
<th>TOTAL NO. OF PAIRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>King Penguin</td>
<td>2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>a few</td>
</tr>
<tr>
<td>Gentoo Penguin</td>
<td>P2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3000</td>
</tr>
<tr>
<td>Adelie Penguin</td>
<td>5000</td>
<td>10</td>
<td>1000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10000</td>
</tr>
<tr>
<td>Chinstrap Penguin</td>
<td>71000</td>
<td>1000</td>
<td>3600</td>
<td>450</td>
<td>26000</td>
<td>100000</td>
<td>46000</td>
<td>150000</td>
<td>96000</td>
<td>75000</td>
<td>0</td>
<td>7500</td>
<td>0</td>
<td>0</td>
<td>1285000</td>
</tr>
<tr>
<td>Macaroni Penguin</td>
<td>N</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3000</td>
</tr>
<tr>
<td>Southern Giant Petrel</td>
<td>0</td>
<td>A3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3000</td>
</tr>
<tr>
<td>Antarctic Fulmar</td>
<td>3500</td>
<td>14000</td>
<td>0</td>
<td>7000</td>
<td>20000</td>
<td>10000</td>
<td>22000</td>
<td>5000</td>
<td>26000</td>
<td>7</td>
<td>low 10000s</td>
<td>13000</td>
<td>7000</td>
<td>5000</td>
<td>90000</td>
</tr>
<tr>
<td>Cape Petrel</td>
<td>1000</td>
<td>250</td>
<td>500</td>
<td>100</td>
<td>15000</td>
<td>12000</td>
<td>7000</td>
<td>15000</td>
<td>15000</td>
<td>200</td>
<td>low 10000s</td>
<td>100</td>
<td>100</td>
<td>60</td>
<td>9000</td>
</tr>
<tr>
<td>Snow Petrel</td>
<td>1000</td>
<td>300</td>
<td>400</td>
<td>300</td>
<td>400</td>
<td>100</td>
<td>100</td>
<td>500</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Dove Prion</td>
<td>N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100s</td>
</tr>
<tr>
<td>Wilson's Storm Petrel</td>
<td>100s</td>
<td>1000s</td>
<td>1000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
<td>10000s</td>
</tr>
<tr>
<td>Black-bellied Storm Petrel</td>
<td>N</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>a few</td>
</tr>
<tr>
<td>Blue-eyed Shag</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>355</td>
</tr>
<tr>
<td>Brown Skua</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>185</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10000s</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10000</td>
</tr>
<tr>
<td>Dominican Gull</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10000s</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>Antarctic Tern</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4. South Sandwich Islands Seabird Population Estimates

Figures in bold are the estimated number of breeding pairs, calculated from the figures below in italics, where P= pairs, ON= occupied nest, NY= nest with chick, UN= used nest, FY=fledged young, A= adults, H= breeding habitat, 0= dead birds or remains, N= probably breeding but not confirmed; ?= possibly breeding; * this survey Jan. 1997; † A. Morton Jan. 1997; ‡ N. Cobley March 1968; † Holgate & Baker March 1964; § Ivanov Jan. 1957; ‡ C. Larsen Nov. 1968; © in Marchant & Higgins 1990, source unidentified. • in Wilson, G. 1983. * pers. comm. P. Prince

41
<table>
<thead>
<tr>
<th>Island</th>
<th>Length of Coastline (km)</th>
<th>No. pairs Antarctic Fulmars</th>
<th>No. pairs Chinstrap Penguins</th>
<th>Surface Area (hectares)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total surveyed</td>
<td>Island Total</td>
<td>Ice-free exposed rock</td>
<td>Ice-free steep high rock cliff</td>
</tr>
<tr>
<td>Thule I</td>
<td>20</td>
<td>21</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Cook I</td>
<td>19</td>
<td>19</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Bellingshausen I</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Bristol I</td>
<td>13</td>
<td>27</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Montagu I</td>
<td>47</td>
<td>47</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>Saunders I</td>
<td>26</td>
<td>26</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Vindication I</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7</td>
</tr>
<tr>
<td>Candernas I</td>
<td>15</td>
<td>15</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Visokoi I</td>
<td>22</td>
<td>22</td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td>Zavodoski I</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Leskov I</td>
<td>0</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Freezland Rock</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
<td>2</td>
</tr>
<tr>
<td>Wilson Rock</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Grindle Rock</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>1.6</td>
</tr>
<tr>
<td>TOTALS</td>
<td>198.7</td>
<td>216.2</td>
<td>146.2</td>
<td>82.5</td>
</tr>
</tbody>
</table>

Table 5. Surface area (in hectares), total length of coastline and total length of coastline (in kilometres) surveyed for each island in the South Sandwich Islands, and breeding populations of Antarctic Fulmars and Chinstrap Penguins.
MAP LEGEND

All soundings in metres ——— Survey track of Damien II

All heights in metres. + breaker or rock awash

(55) Height above sea level in metres † anchorages used during survey

Contour lines are descriptive and do not necessarily correspond with fixed heights

GT Gentoo Penguin ●●●● area shoal or suspected to be shoal
AD Adelie Penguin ○○○○ area of exposed rock
CH Chinstrap Penguin ○○○○ area of ice or snow (except on
MP Macaroni Penguin ○○○○ area occupied by Macaronis
GP Southern Giant Petrel ○○ ○○ Wilson and Grindle Rocks
AF Antarctic Fulmar ○○ ○○ area occupied by Chinstraps
CP Cape Petrel ○○ ○○ area occupied by Macaronis
SP Snow Petrel ○○ ○○ which are completely ice-free
DP Dove Prion ○○ ○○
WSP Wilson's Storm Petrel ○○ ○○
BSP Black-bellied Storm Petrel ○○ ○○
SH Blue-eyed Shag ○○ ○○
SK Brown Skua ○○ ○○
DG Dominican Gull ○○ ○○
AT Antarctic Tern ○○ ○○

CH 1000 an estimated one thousand pairs of Chinstraps
Fig. 1

South Sandwich Islands

Leskov Island

Zavodovski Island

Visokoi Island

Vindication Island

Candlemas Island

Saunders Island

Montagu Island

Bristol Island

Thule Island

Bellinghausen Island

Cook Island

Fig. 1
MONTAGU ISLAND

Fig. 6

[Map of Montagu Island with various points labeled, such as Borley Point, Hollow Point, Horsburgh Point, Leeson Point, and Scarlett Point.]

26°20'W

km

0 1 2 3
VINDICATION ISLAND

Fig. 8

Saw Rock (34)

AF CP

AF 60

CROSSCUT POINT

CP 130

AF 150

AF 100

AF 200

CP 200

AF 40

CP 5

CSPL INFRA CRAB 74

LEAF

26°47'W

km

51
The Clerke Rocks are situated approximately 75km (40 nautical miles) east-south-east of South Georgia at latitude 55°00'S and between longitudes 34°45'W and 34°36'W. The group consists of two main clusters of islands, islets, stacks and rocks extending 9km (5nm) from east to west, and separated by a 4km (2nm) wide passage.

The islands are completely ice-free and rise steeply from the sea, their sharp summit ridges giving the group a conspicuously jagged silhouette. The rock substrate appeared light-grey to pinkish in colour, traversed with darker coloured bands (dykes) in places.

The shoreline is steeply shelving and the littoral and intertidal zones completely exposed to wave action at all times. A sparse covering of marine algae clings to the rocks in the intertidal zone but there were no kelp beds fringing the shore. In rough weather it was thought that seas would break on the cliffs up to about 8m height above the sea, and higher still in storms. There are no sheltered landing beaches, and even in calm conditions, ground swell makes landings are difficult.

Being composed entirely of sheer cliffs and steep rock slopes, there are very few beaches or scree areas. In about a dozen different locations, the rock face was split by a narrow ravine or gulch, which often sloped to a small boulder beach or rock debris slope below. It was here that Fairy Prions and Fur Seals were seen.

No detailed map or chart exists of Clerke Rocks. During the survey, accurate fixes were obtained of island using a hand-held Global Positioning Satellite System (GPS) while the boat passed within 15m to 25m from the shore. The positions of all islands, islets and the principal stacks were plotted on a 1:20 000 sketch map. No shoal areas were observed in the approaches to the islands.

The western group contains the two largest and highest islands of Clerke Rocks. "Main Island", the largest island, is roughly circular in shape, with a maximum length of 1km. It has a double summit, the higher peak being recorded as 244m above sea level, while the lower was estimated to be approximately 200m. There were several ravines or gulches around its coast. "Second Island", lying close east-north-east of "Main Island" was also roughly circular, and about 0.5km in length, with a central peak close to 150m altitude. Close north of Main Island is a group of several islets, stacks and numerous rocks, "Main Islets", whose maximum altitude is approximately 50m.

The eastern group consists of one main island and and two separate groups of numerous small islands, islets, stacks and rocks. Its silhouette is markedly jagged, resembling the teeth of a saw. The easternmost and largest island, Nobby, is roughly circular, less than 500m in length and with a central summit peak about 60m above sea level. The Office Boys lie about 700m west of Nobby, and consist of numerous small islands, islets, stacks and rocks stretching over 1km from south-west to north-east in a 'S'-shaped line. Very narrow channels separate the islets and stacks. The largest island, with a reported height of 82m, is in fact divided by steep ravines in several places, through which the sea washes. The second group of islets and stacks ("Middle Stacks") lies 1km west-south-west of the Office Boys, and is the smaller of the two groups. Its half dozen or so islets are less than 100m in length and rise to less than 30m above sea level. A low rock, awash and visible lies approximately 0.5nm south-east of "Middle Stacks".
Vegetation

The islands appeared to be virtually all bare rock, although areas adjacent to the larger Macaroni Penguin colonies were covered in a green-coloured algae (probably *Prasiola* sp.) and no doubt lichens.

On "Main Island" there was a sparse covering of low tussac *Parodiochloa flabellata* growing in shallow soil in crevices and on ledges along the west coast cliffs at between 50m and 150m altitude. A few Black-browed Albatrosses nested on these cliffs, scattered in and around the patchily distributed tussac.

**Gentoo Penguin** *Pygoscelis papua*

No breeding groups were seen, although over 200 birds were seen resting on the outskirts of a Macaroni colony on The Office Boys.

**Chinstrap Penguin** *Pygoscelis antarctica*

This species did not breed on the islands, although over 100 birds were seen resting on a stack in The Office Boys.

**Macaroni Penguin** *Eudyptes chrysolophus*

There were six colonies of Macaroni Penguins at Clerke Rocks, totalling approximately 16,000 pairs. They nested on the steep coastal slopes up to altitudes of about 100m.

In the western group, there were three colonies, each with 3000-4000 pairs: one on the north-west point of "Second Island", and two on the east coast of "Main Island". In the eastern group, two colonies of 500 and 2500 pairs were seen on the highest island of The Office Boys, and a small colony of 300 pairs on a stack close east of this. A third colony on Nobby contained 2300 pairs nesting all over the island.

**Black-browed Albatross** *Diomedea melanophris*

Black-browed Albatrosses were recorded nesting on "Main Island" and "Second Island", with a total of 997 occupied nests counted. The breeding population was estimated to be between 1100 and 1500 pairs. They nested on steep rock slopes and cliffs between 20m and 200m altitude. In the absence of tussac grass (which was only seen at one location), nesting materials probably consist of guano, crevice soil, feathers, and the remains of dead birds.

On "Main Island" 372 occupied nests were counted, with 240 recorded on the north-east coast above the large Macaroni colony up to nearly 200m altitude; 69 scattered along the west coast cliffs among the sparse tussac patches, and 63 on the south point above the Macaroni colony.

The "Second Island" population totalled 525 occupied nests, all situated from about 50m to 100m altitude mainly on the north coast cliffs.

**Light-mantled Sooty Albatross** *Phoebetria palpebrata*

It is unlikely that this species breeds at Clerke Rocks. However, two individuals were seen soaring along the slopes of "Main Island" and Second Island", in a manner suggesting the presence of a suitable nest-site, but no birds were seen landing.
Cape Petrel *Daption capensis*

Cape Petrels were recorded nesting mainly on "Main Island", and "Second Island" with a few pairs seen on The Office Boys. The total population was estimated at between 1000 and 2000 breeding pairs. Nests were on cliff ledges at all altitudes.

**Fairy Prion** *Pachyptila turtur*

Fairy Prions were seen at seven locations on three islands. The centre of the population appeared to be on "Main Island" where five possible breeding sites were recorded. Another site was seen on the north coast of the largest islet in the "Main Islets", and one on the largest island in The Office Boys. These sites were also recorded in December 1990 (per. comm. J. Poncet).

Breeding sites are typically at the head of narrow gulches and ravines that occasionally intersect the coastal cliffs. Birds were observed flying close over the boulder and scree debris that accumulates on the ravine floors, this being preferred nesting habitat for Fairy Prions at other sites in South Georgia. Although breeding was not confirmed, it is thought that 500-1000 pairs could nest on the islands.

**Wilson's Storm Petrel** *Oceanites oceanicus*

There is ample suitable breeding habitat for this species on all the islands and larger islets of Clerke Rocks. Several birds were seen flying over scree slopes and it is possible that the population is at least several hundred pairs.

**Blue-eyed Shag** *Phalacrocorax atriceps*

A total of 1260 occupied nests were counted. Nests were occupied by adults and large chicks, and it is estimated that the total breeding population was approximately 1300 pairs. Nineteen colonies were recorded on twelve islands and islets, with the largest concentrations being on Nobby (193 nests), the highest island in The Office Boys (254 nests), the largest islet in "Main Islets" (227) and "Main Island" (172 nests). Colonies were situated on cliffs from 20m to nearly 200m altitude.

This is in marked contrast to the 1990-91 summer, when no shags were recorded nesting on the islands, and only a few individuals were seen resting, when the group was visited in December 1990 (pers. comm. J. Poncet).

**Brown Skua** *Catharacta lombardi*

Although it seems likely that the Macaroni Penguin colonies could provide sufficient food for several pairs of skuas, only two birds were seen. Confirmation is needed of the breeding status of this species.

**Dominican Gull** *Larus dominicanus*

No Dominican Gulls were seen. There are no protected inshore waters or intertidal zones at the Clerke Rocks for littoral-dependent foragers such as gulls to feed, and this possibly explains the absence of this species.
**Snowy Sheathbill Chionis alba**

Over 200 sheathbills were seen, mainly in the vicinity of Macaroni colonies, and although no nests were seen, it is likely that around 50 pairs could breed at Clerke Rocks.

**Southern Fur Seal Arctocephalus gazella**

Three suitable fur seal breeding beaches were located, one on the north coast of the largest islet in the "Main Islets" group, one on the east coast of "Main Island", and the third on the east coast of the largest island in The Office Boys. At this last site, 2 pups were seen with 111 adults. From the boat, no pups were visible at the first two sites, although 83 adults were seen on the "Main Island" beach. Shore counts would be necessary to count pups at these sites, since sections of the beaches are not visible from the boat.

These sites were surveyed in December 1990 during a fur seal survey of South Georgia carried out by BAS aboard Damien II. In that season, approximately 100 pups were estimated to have been born at Clerke Rocks, after landings and counts were effected at both the "Main Islets" and The Office Boy beaches. As in 1997, no pups were seen on the Main Island beach. Although no shore counts were done during the 1997 survey, it would appear that there were fewer pups born than in 1990.
<table>
<thead>
<tr>
<th></th>
<th>Clerke Rocks - western group</th>
<th>Clerke Rocks - eastern group</th>
<th>Estimated Breeding Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Main Island&quot; &quot;Second Island&quot;</td>
<td>&quot;Main Islets&quot; &quot;Middle Islets&quot;</td>
<td>The Office Boys Nobby</td>
</tr>
<tr>
<td>Gentoo Penguin</td>
<td>0 A2 0 0 0</td>
<td>0 0 A200 A1 0</td>
<td>0</td>
</tr>
<tr>
<td>Chinstrap Penguin</td>
<td>0 0 0 0 0</td>
<td>0 0 A100 A20 0</td>
<td>0</td>
</tr>
<tr>
<td>Macaroni Penguin</td>
<td>7200 3000 20</td>
<td>0 3300 2300 1600</td>
<td></td>
</tr>
<tr>
<td>Black-browed Albatross</td>
<td>372 625 0</td>
<td>0 0 0 1200 0</td>
<td></td>
</tr>
<tr>
<td>Light-mantled Sooty Albatross</td>
<td>? 0 0 0 0</td>
<td>0 0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Cape Petrel</td>
<td>500-1000 50-100 0</td>
<td>0 33 ON 1 1000-2000</td>
<td></td>
</tr>
<tr>
<td>Fairy Prion</td>
<td>100s 0 N</td>
<td>0 N 0 500-1000</td>
<td></td>
</tr>
<tr>
<td>Wilson's Storm Petrel</td>
<td>N N ?</td>
<td>N H N 100s</td>
<td></td>
</tr>
<tr>
<td>Blue-eyed Shag</td>
<td>172 121 253</td>
<td>46 475 193 1100-1500</td>
<td></td>
</tr>
<tr>
<td>Brown Skua</td>
<td>0 0 0 0 0</td>
<td>0 0 N A1 0 0</td>
<td>0</td>
</tr>
<tr>
<td>Dominican Gull</td>
<td>0 0 0 0 0</td>
<td>0 0 0 0 0</td>
<td>0</td>
</tr>
<tr>
<td>Snowy Sheathbill</td>
<td>N N 0</td>
<td>N N N 50</td>
<td></td>
</tr>
<tr>
<td>Fur Seal</td>
<td>A83+?pups 0 A8+0 pups</td>
<td>0 A20+2 pups A111+2 pups</td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Clerke Rocks seabird and Fur Seal population estimates
Fig. 13

CLERKE ROCKS - WESTERN GROUP
CLERKE ROCKS - EASTERN GROUP

Fig. 14
REFERENCES


Woehler, E.J. 1993. The Distribution and Abundance of Antarctic and Subantarctic Penguins. SCAR.