Gough Island Bird Monitoring Manual

Research Report

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Summary

Gough Island, in the central South Atlantic Ocean, is one of the most important islands in the world for seabirds – supporting over 20 breeding species and millions of pairs. It also holds two endemic landbird species. Eight of the bird species that nest there are globally threatened.

Gough's bird populations are likely to be vulnerable to several negative factors. Island wildlife is often devastated by the introduction of alien invasive species. Longline fishing is known to have impacted many albatross and petrel species worldwide. There is widespread concern about the effects of new fisheries and climate change on the ecosystems of the Southern Ocean.

A key feature of effective biodiversity conservation is regular quantitative monitoring of important populations: it permits conservation problems to be identified and prioritised, and allows the success of conservation measures to be measured. However, despite the global importance of Gough, there has hitherto been very little monitoring of the bird populations.

To address this problem, the Gough Island bird conservation project, funded by the UK Foreign & Commonwealth Office, took place between 2000 and 2002. The Royal Society for the Protection of Birds (UK) and the Percy FitzPatrick Institute of African Ornithology, University of Cape Town, (South Africa), jointly managed the project.

The project aimed to assess the status of the threatened and endemic bird species, to make new population estimates, and to develop and record long-term monitoring protocols. Fieldwork on Gough Island by a two-person team took place between September 2000 and September 2001.

The purpose of this report is to outline reliable and repeatable census protocols for each of the eight globally threatened bird species, thereby making it easier for future workers to repeat and interpret the counts undertaken during 2000–2001. This will allow long-term quantitative monitoring of population trends.

We summarise the count methods and areas surveyed for each species, and where applicable discuss other methods that were tried and tested. The estimated population size and evidence for population trends are briefly discussed for each species. A general introduction to fieldwork on Gough is provided, and appendices and supplementary material provide detailed information on location of long-term monitoring plots.

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The project was managed by Dr Geoff Hilton for the RSPB and Dr Peter Ryan for the Percy Fitzpatrick Institute.

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1 Introduction

Gough Island, part of the UK Overseas Territory of Tristan da Cunha, is located in the middle of the South Atlantic Ocean (40∀21' S, 9∀53' W) approximately 3,000 km from South Africa and South America, and 350 km south-east of Tristan da Cunha (Figure 1.1). It is a volcanic island, c 65 km^2 in area, with steep mountainous terrain. There is a permanent weather station, run by the South African Department of Environmental Affairs and Tourism, but no other habitation (Cooper & Ryan 1994). Gough Island is a UNESCO World Heritage Site and is arguably the most important seabird island in the world (Collar & Stuart 1985), with 20 breeding seabird species, and millions of pairs in total. It holds virtually the entire world population of the globally threatened Tristan albatross *Diomedea dabbenena* and Atlantic petrel *Pterodroma incerta*. Four other globally threatened seabirds breed on the island: the world's largest population of sooty albatrosses *Phoebetria fusca*, the second largest population of Atlantic yellow-nosed albatrosses *Thalassarche chlororhynchos*, and over 100,000 pairs of northern rockhopper penguins *Eudyptes chrysocome moseleyi*, plus smaller numbers of southern giant-petrels *Macronectes giganteus*. It is probably the most important site in the world for several other (non-threatened) burrowing petrels, including great shearwaters *Puffinus gravis*, Kerguelen petrels *Pterodroma brevirostris* and broad-billed prions *Pachyptila vittata* (Richardson 1984; Cooper & Ryan 1994; BirdLife International 2000). There are also two globally threatened endemic landbirds, the Gough moorhen *Gallinula comeri* and Gough bunting *Rowettia goughensis*, whose presence qualifies Gough Island as an Endemic Bird Area (Stattersfield et al 1998).

Although Gough Island is clearly of great significance for bird conservation, the difficulties of access and mountainous terrain mean that knowledge of its avifauna is still relatively poor. In spite of the enormous ornithological importance of Gough, only once (in 1955, see Swales 1965) has an ornithologist stayed on the island for more than a few weeks. The most recent estimates for the population size of albatross species on Gough mostly date from as far back as 1972–4 (a small amount of data are available from 1982).

Despite its isolation, the seabird colonies on Gough are thought to be under substantial threat, due to the impact of longline fishing, which causes mass mortality through drowning of birds caught on the hooks. There is a strong presumption that many of the bird populations on Gough must be in decline due to mortality on longlines (eg Gales 1998; Gales *et al* 1998). At present however, our knowledge of population sizes and trends is so poor that it is impossible to determine how severe the problems are, nor do we know the ocean areas in which Gough breeding birds interact with fisheries operations.

This report summarises the results of a one-year study on the island, initiated by the Royal Society for the Protection of Birds and the Percy Fitzpatrick Institute (University of Cape Town). The fieldwork made baseline population estimates of the species of conservation concern, established monitoring programmes for these species and evaluated their conservation status. The purpose of this report is to provide a manual of standardised count methods for bird species breeding on Gough Island by outlining reliable and repeatable census methods that will allow the monitoring of future population trends.

Figure 1.1: The South Atlantic and Indian Oceans, indicating the position of Gough Island and other main islands.

2 Methods

2.1 General fieldwork methods

Most fieldwork was undertaken in the south-east of Gough Island in the areas surrounding the Meteorological Station (Figure 2.1). The main study sites included The Glen and Sophora Glen and beaches from the Admirals to South Point (rockhopper penguins); the fernbush and coastal tussock habitat from Waterfall Point to Richmond Hill (Atlantic yellow-nosed albatrosses, Atlantic petrels), and sea cliffs in this area (sooty albatrosses); and Gonydale (Gough buntings). Tristan albatrosses are located on the island's plateau above 350 m asl, although they are absent from the areas to the north-east of Nigel's Cap and Diego Alvarez. Breeding colonies of southern giant petrels are located to the south of Triple Peak and in the area to the south-west of Low Hump.

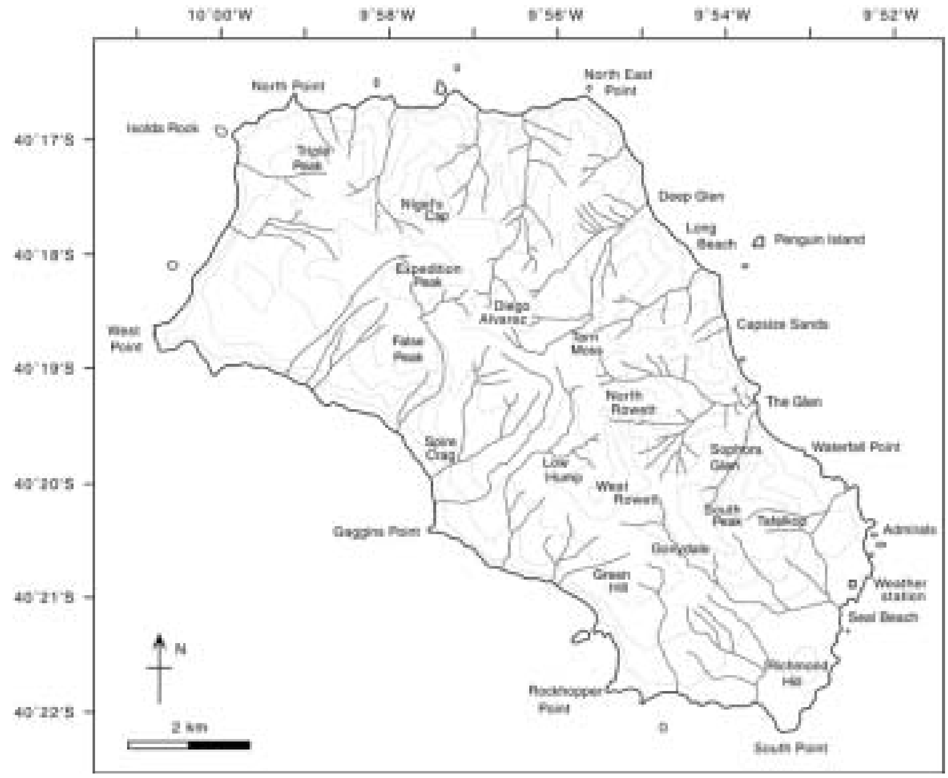

Figure 2.1: Gough Island. The vertical distance between contour lines is 150 m.

In selecting the survey methods and count areas for each species, we considered nine criteria. These criteria were used to help define the methods needed to census each species, with the aim of providing reliable and repeatable census methods that will be statistically robust. Ranked in order of decreasing importance these were:

- Clearly defined areas that can be recognised by future fieldworkers
- Repeatability of the methods by different observers
- Accessibility and safety of all count sites
- Likely time-scale of future surveys
- Conservation status and priority of each species
- Probable time-scale and magnitude of population declines
- Proportion of the total population within the count areas

- Spatial independence of count areas
- Count areas of varying densities

The count methods for each individual species are detailed in the species accounts. However, certain methods and terms are shared by several species and these are defined here.

'Ground counts' were conducted on foot by slowly walking through an area or colony of breeding birds and visiting every nest to check for an egg, with a tally of occupied nests being recorded on a mechanical counter. Birds on empty nests and loafers were also counted during these surveys, and it was necessary to keep a check on the movements of these individuals to avoid double counting. Ground counts were made within defined areas of the breeding colony that were demarcated by natural features such as rocks, trees or streams. Where no natural features were available we used spray paint to mark the edge of a count area to avoid recounting nests. For ground counts of Tristan albatrosses we marked and numbered every nest.

'Scan counts' were made through binoculars over breeding areas or colonies, with a tally being kept of Apparently Occupied Nests (AONs) and of loafing birds. Scan counts were made of cliff-nesting sooty albatrosses, incubating adults and chicks of Tristan albatrosses, southern giant petrels and of some rockhopper penguin colonies. Where possible, well-defined landmarks (ridges and streams for Tristan albatrosses, and sections of cliff for sooty albatrosses) were used to limit the potential for double counting birds.

'Occupied nests' were only counted during ground counts, and were recorded when every nest and bird could be checked for the presence of an egg.

'Bird on empty nest' was recorded during ground counts, and occurred when a bird was sitting on a nest but with no egg. This category included birds that may have been non-breeders, failed breeders or that had yet to lay.

'Apparently Occupied Nest' (AON) was recorded during scan counts, and consisted of birds that were sitting on nests and appeared to be incubating an egg. This required some element of subjectivity, but the posture and behaviour of birds would often give a good indication of an incubating bird (eg remaining tightly sitting and not responding to the presence of other courting birds, or acting aggressively to subantarctic skuas.

'Loafers' were birds in the count area that were sitting or standing in the colony and were not incubating an egg(s) or sitting on empty nests. Loafers include partners of incubating birds, non-breeders, immatures and juveniles. Loafers were recorded during ground and scan counts.

Where possible the reliability and repeatability of the chosen methods were tested. Ground counts and scan counts of Tristan albatrosses showed good agreement, suggesting that scan counts are reliable for this species. Ground counts and scan counts of rockhopper penguins revealed substantial but relatively consistent differences, allowing a correction to be made. It was not possible to test the accuracy of sooty albatross scan counts, although these are likely to underestimate the actual numbers (Moore 1996). Between-observer differences were tested for scan counts of rockhopper penguins, Tristan albatrosses, burrow occupancy of Atlantic petrels and point counts of Gough moorhen calls. No significant differences were found between observers. These tests are discussed in more detail within the relevant individual species account.

The main areas of each vegetation type on Gough Island were mapped over the course of the year. There are five main vegetation types on Gough Island: coastal tussock, fernbush, upland wet heath habitat, feldmark and peat bogs (see Wace 1961 and Cooper & Ryan 1994 for a detailed description of these vegetation types). The highest areas of Gough Island and areas around Nigel's Cap (Figure 2.1) consist of bare rock and scree. The vegetation map was used to estimate the area of major habitat types, and these estimates are subsequently used in the population estimates of some species. Because of the steep and complex topography of Gough Island, no account of slope angle was made in the area estimates and consequently the area estimates will underestimate the true area of each habitat.

2.2 Disturbance of wildlife

Working in densely packed seabird colonies can often cause disturbance to birds on nests. The effect of this disturbance depends on the species involved and the stage of the breeding season. Most birds are more vulnerable to disturbance during the incubation period. Colony checks around incubating birds should be kept to a minimum. Southern giant petrels are very prone to disturbance and, particularly because of their small population size, great care should be taken when counting this species (see methods). Rockhopper penguins are also vulnerable to disturbance, as the breeding colonies are so tightly packed with birds.

To avoid excessive disturbance fieldworkers should walk slowly and carefully at all times, and should take note of any signs of agitation of birds on nests. If a bird jumps off its nest it will usually hop back on once you have moved off. Very stressed birds will sometimes walk/run away from the nest (some Atlantic yellow-nosed albatrosses were prone to this). These birds can usually be carefully herded back towards the nest. If a bird flies away from the nest then it may well return when the person has moved off. Cover the unattended egg with grass to prevent predation.

Exposed eggs and small chicks may attract the attention of subantarctic skuas *Catharacta antarctica*. Skuas are very quick to spot unattended eggs, as they frequently fly over colonies or watch from vantage points. They are unafraid of humans and will try to take eggs from alongside fieldworkers. If the egg or chick is not being held, then it should be covered with a hat or glove to avoid attracting skuas.

If the weather is more inclement than usual, then avoid exposing eggs or young chicks to the weather or to the risk of desertion by the parents. Avoid disturbing or handling birds unless it is absolutely necessary and is essential for the fieldwork. Taking photographs is normally fine, but as a good general rule, if a bird starts to react to your presence then you are too close. When handling birds, hold them firmly and do not react if the bird is trying to bite you. If the bird is not able to struggle and you are calm then they will usually not become overly stressed.

2.3 Environmental impact

The vegetation of Gough Island, particularly in the upland areas, is prone to erosion. The feldmark vegetation (Wace 1961; Cooper & Ryan 1994) of the uplands consists mainly of grasses and mosses and forms a thin layer on the peaty soil. This layer is easily broken when walking on steep sections, and footprints and erosion will last for many years. To try to avoid excessive erosion, fieldworkers should stick to existing paths. Less erosion is created when following ridge crests, and traversing steep slopes should be avoided where possible. Bogs and mires are easily damaged, and again should be avoided.

The denser and more robust vegetation of the lowlands, which are dominated by the island tree *Phylica arborea* and ferns (mainly *Histiopteris incisa* and *Blechnum palmiforme*), are less prone to erosion or damage, and establishing a path is useful for accessing Gonydale and other upland areas. The lowland areas of the island are heavily burrowed with the nests of millions of burrowing petrels. These burrows are occasionally collapsed when walking, particularly in areas of coastal tussock, which is softer and more friable than fernbush habitat. Collapsed burrows should be dug out to ensure a bird has not been buried or trapped within its burrow. Where the hole is directly above an incubating bird or chick, the hole should be covered and plugged with sticks, ferns or other vegetation.

Nocturnal birds are attracted to the lights of the weather station on Gough Island and on dark foggy nights dozens of birds may become disorientated and strike the base. Birds are only rarely injured by this (although they can be stunned), but become easy prey for skuas whose territories are around the base. While the base has been fitted with blinds these are sometimes left open, and on very dark nights the base should be checked for light. Birds that have struck the base should be collected. If they are dazed then place them in a cardboard box in a dark and quiet place to recover and release them later that night or the next night. If birds are active and uninjured then the easiest solution is to take them along the catwalk towards the helipad and release them 200 m from base.

Introduced species represent a severe threat to the endemic plants and wildlife of Gough Island. All gear taken to Gough Island should be thoroughly checked to ensure that potential pests (insects and plants) are not introduced. Ideally, all fieldwork kit taken to Gough Island should be new. Where this is not practical, all existing kit should be thoroughly washed and cleaned. Check the inside of tents and Velcro on clothes and gaiters for seeds. For a more detailed account of these issues, see Cooper & Ryan (1994).

2.4 Health and safety

Preface

Fieldwork on Gough Island is physically demanding. The remoteness, harsh terrain and inclement weather mean that without careful attention to health and safety procedures, it can also be dangerous. The need for caution and thorough preparation while conducting fieldwork on Gough cannot be over-stated. Training of fieldworkers should include outdoor first aid, mountain walking and navigation, unless the fieldworker is already competent in these areas.

The guidance contained within this manual cannot and should not be used in isolation, but in conjunction with your own organisation’s heath and safety policy, and internal procedures, instructions and guidance. The guidance does not offer definitive answers to all health and safety related issues on Gough Island, but covers a range of situations that we have experienced. Future fieldworkers on Gough must make their own judgments concerning appropriate health and safety procedures, and the authors and publishers of this manual cannot accept responsibility for any consequences arising from the use of this document by individuals/organisations.

Navigation and moving around on Gough

All researchers should be fit and confident at walking and navigating over very rough terrain and in often atrocious weather. Fieldworkers should have good experience of camping and working in remote areas, and should be competent at navigating in bad weather using a compass and dead reckoning, as well as with a handheld GPS. High quality camping equipment is necessary to survive the Gough weather, and sheltered camping sites should be used, even in calm weather, as rapid changes can take place. Good footwear is essential (see Appendix 2), and walking poles are useful. Particular care needs to be taken to avoid falls where working in steep terrain (see

Appendix 2 for concerns about the use of waterproof overtrousers in steep vegetated areas). Fixed ropes and rope ladders are provided at various points around the island to facilitate access down steep slopes. The ropes are made of synthetic material and of braided construction, and in most cases were not designed to bear a human's weight. Furthermore, all synthetic material degrades with prolonged exposure to UV light, and will fray if continually dragged against rocks, and most ropes on the island are showing signs of such wear. Wooden rungs on rope ladders are also becoming rotten in some places. For these reasons, extreme caution should be exercised when using ladders and ropes to move on Gough Island. All ropes and ladders should be checked at regular intervals and replaced as soon as any wear is evident or after the manufacturer's maximum recommended outdoor exposure period, whichever occurs first.

Equipment

Appendix 2 lists suggested fieldwork equipment for Gough Island. At all times fieldworkers should carry a waterproof jacket and over-trousers, warm inner layers, Goretex bivvy-bag or plastic survival bag, spare food, map and compass, handheld GPS, and communications equipment.

The severe terrain and inclement weather of Gough Island means that even relatively minor injuries may create serious and life-threatening situations. While there is always a medic on the weather station, there will be occasions when the weather or the terrain means it will be at least 24 hours before the medic could get to an accident (in fact one to three days is not unexpected). Consequently, all researchers should have recent experience of a first aid course (preferably one geared to outdoor situations) and carry a first aid kit.

Wildlife

While not life-threatening, injuries from birds and seals are possible on Gough Island. Subantarctic fur-seals can be aggressive, particularly males defending a beach territory, and even pups can bite and draw blood. Where possible, avoid beaches during the main breeding season (September – January). If you have to walk along beaches during these periods, then making lots of noise (clapping hands, banging a stick on the rocks) will, with patience, clear a seal space. Thoroughly wash all seal bites (preferably with hot water, but in seawater if necessary) and treat with Iodine. Tetanus inoculations are usually necessary. Birds are also likely to cause cuts by scratching and biting. These should not be serious, although Tristan albatrosses can inflict a severe bite, and this is potentially serious if on the face. Ensure that the beak of the bird is held at all times while checking rings, even apparently docile birds that appear to be unstressed by your presence will occasionally try to bite.

Communications with base

Daily radio-scheds provide an important safety mechanism to ensure that help can be sought if accidents occur. Establish a regular radio-time with the base and make sure there is a back up time. Plan what is to happen if base does not hear from you at the agreed time. Before departing base, leave a record of where you are undertaking fieldwork, and estimated time of return. Regular radio-scheds are also a useful means of obtaining warning of approaching bad weather, and can make the difference between crawling in sleet back over Windy Ridge versus strolling in the sun. Fieldworkers should make a decision regarding the use of satellite phones, short-wave radios, or both. It is very important to carry spare batteries. During fieldwork in 2003, a 'buddy system' was set up with the base using Iridium satellite phones, with fieldworkers having to phone the base twice daily at 7 am and 7 pm. During these calls, the fieldworkers would confirm they were safe, check the weather forecast and divulge the area they would be working in the following day. If two calls were missed a rescue team would search the area they would have been working in. This system worked well and could be considered for all overnight trips away from the base.

Boat use

Wet suits and life jackets should be worn when travelling in small boats, and pick-up plans and contingency plans should be arranged. Both the Glen and Sophora Glen are protected from the mainly westerly and north-westerly weather that Gough Island receives. However even a slight southerly wind quickly creates waves and surf that would make landing at either of these two areas impractical and dangerous. People visiting the Glen and Sophora Glen should take food to last for several days, and if bad weather continues should be prepared to walk overland back to the base.

3 General results

The monitoring protocol for each species is detailed in the individual accounts; however a summary of the methods used and timing for monitoring is presented in Table 3.1. For most species, ground counts or scan counts were the main methods used, with additional counts of burrow density and occupancy for burrowing petrels, nest mapping for Gough buntings and subantarctic skuas, and point counts for Gough moorhens. For each species, the number of survey sites and approximate percentage of the breeding population counted is presented in Table 3.2.

Table 3.1: Main survey methods and timing for monitoring priority bird species on Gough Island.

Species	Survey method	Timing of monitoring
Rockhopper penguin	Ground count of incubating birds	October
Tristan albatross	Ground/scan count of incubating birds	January – February
	Ground/scan count of large chicks	September
Atlantic yellow-nosed albatross	Ground count of incubating birds	October
Sooty albatross	Scan count of incubating birds	October
Southern giant petrel	Ground/scan count of incubating birds	September
Atlantic petrel	Density of burrows and burrow occupancy	July or September
Gough moorhen	Point counts and trapping	September – January
Gough bunting	Mapping of nest sites	November – December

Table 3.2: Number of survey sites and approximate proportion of the estimated total population counted with the survey areas.

Species	Number of sites	Per cent of total population
Rockhopper penguin	6	5%
Tristan albatross	Whole island	100%
Atlantic yellow-nosed albatross	11	11%
Sooty albatross	17	6%
Southern giant petrel	2	99%
Atlantic petrel	3	<1%
Gough moorhen	2	-
Gough bunting	1	3-4%

Coastal tussock, fernbush and upland wet-heath are the principal habitats that support bird populations on Gough Island, and the resulting habitat map closely corresponded to the vegetation map of Wace (1965), although the habitat was mapped at a finer scale in this study. The estimated area of each of these three habitats is 4.6 km^2 of coastal tussock, 10.4 km^2 of fernbush habitat, and 15.2 km^2 of upland wet-heath. No account of slope angle was made in these area estimates due to the complicated topography of Gough Island. Mapping of Gough Island indicated a coastline perimeter of c 42.1 km.

While the primary objective of the research and this report is to provide methods for long-term monitoring of birds on Gough Island, the results of the fieldwork also enable us to make population estimates of some species. More detailed information on population sizes will be published elsewhere, but in each species account we briefly summarise the main findings and conservation implications of the population estimates, and where possible compare these with earlier estimates. All statistics in the individual species accounts are presented as ∂ one standard deviation unless otherwise specified, and results are assumed to be significant at $p < 0.05$. New and previous population estimates for birds on Gough Island are summarised in Table 3.3. Due to profound differences in survey methodology and thoroughness, the new estimates should be treated as reassessment of population size, rather than as evidence for changes in numbers since previous counts.

Table 3.3: Population estimates of birds breeding on Gough Island.

Species	**Estimated number of breeding pairs**	
	Previous estimate	**This study**
Rockhopper penguin *Eudyptes chrysocome*	144,235	145,000
Tristan albatross *Diomedea dabbenena*	1,000*	1,500*
Atlantic yellow-nosed albatross *Thalassarche chlororhynchos*	5,000	5,250
Sooty albatross *Phoebetria fusca*	5,000*	5,000*
Southern giant petrel *Macronectes giganteus*	110	230
Kerguelen petrel *Pterodroma brevirostris*	> 20,000	> 50,000
Greatwinged petrel *Pterodroma macroptera*	> 5,000	> 10,000
Atlantic petrel *Pterodroma incerta*	> 20,000	1,720,000
Soft-plumaged petrel *Pterodroma mollis*	> 50,000	420,000
Broad-billed prion *Pachyptila vittata*	> 100,000	1,800,000
Grey petrel *Procellaria cinerea*	> 10,000	>10,000
Great shearwater *Puffinus gravis*	300,000	980,000
Little shearwater *Puffinus assimilis*	> 10,000	>5,000
Grey-backed storm-petrel *Garrodia nereis*	> 10,000	-
White-faced storm-petrel *Pelagodroma marina*	> 10,000	-
White-bellied storm-petrel *Fregatta grallaria*	> 10,000	-
Common diving-petrel *Pelecanoides urinatrix*	> 20,000	-
Subantarctic skua *Catharacta antarctica*	500	1000
Antarctic tern *Sterna vittata*	500	500
Brown noddy *Anous stolidus*	200	200
Gough moorhen *Gallinula comeri*	2,500	3500 – 4,250
Gough bunting *Rowettia goughensis*	1,000	400 – 500

4 Individual species accounts

4.1 Rockhopper penguin *Eudyptes chrysocome*

Rockhopper penguins were censused through ground and scan counts of incubating birds along five separate areas of the coast (see Appendix 3.1). All counts were completed during mid-October to early November 2000, during the early stages of incubation. Numbers of large chicks were counted in four areas during mid-January 2001, enabling breeding success to be estimated.

Ground counts were completed by both observers with one person counting all birds incubating eggs and the other counting birds either on empty nests or within the colony and not associated with any nest. Most non-incubating birds would stand up and/or move and we assumed that all birds remaining 'tightly sitting' were incubating an egg. All areas of the colony were searched, including underneath boulders and tussocks. Where possible the colony was broken up into definable count sections, and these were counted separately. Bird numbers were recorded with hand-held tally-counters. The number of surviving chicks was re-counted on foot, with all areas of the colonies being searched for birds.

Scan counts were made from areas of cliff overlooking the colonies, with both observers making repeated counts. Where possible, colonies were sub-divided into separate definable areas to make scan-counts easier. All colonies were counted through binoculars using click-counters. Only 'apparently-incubating' birds were counted, with this being determined by the posture of the bird.

Results

The total number of incubating birds counted in each area by either ground or scan counts is presented in Table 4.1.1. Nearly 8,000 incubating birds were counted (after extrapolating in two areas to correct for the underestimate from scan counts; see below), approximately 5% of the estimated island population of 144,235 pairs in 1984 (Watkins 1987). Three sites were counted on foot and were also scan counted. The scan counts on average underestimated the number of breeding pairs by 41.8% (SE = 3.9%). There were no differences between observers in the numbers of birds counted during scan counts (paired t-test, $t_{0.05,4} = 1.25$, N S), and the coefficient of variation from repeated scan counts made by observers was also low (CV = 13.2%).

Three colonies (comprising six sub-areas) were recounted during mid-January to estimate the number of surviving chicks. Breeding success averaged 36.2% (SE = 2.8%), and there was relatively little variation in breeding success between the six areas (Table 4.1.2). A ground count of Sophora Glen was made for the first time during this period. Extrapolating back from the number of chicks counted and the average breeding success observed in the other areas gives an estimated breeding population of 1,587 pairs in Sophora Glen. This estimate is similar to the total of 1,767 birds estimated from the scan count of Sophora Glen, after correcting for the proportion of birds underestimated by scan counts (Table 4.1.1).

Table 4.1.1: Ground counts and scan counts of incubating and loafing rockhopper penguins counted at six sites on Gough Island during the 2000/2001 breeding season.

		Ground counts			Scan counts		
Site	**Location**	**Date**	**Incubating birds**	**Loafing birds**	**Date**	**Incubating birds**	**Under-estimate**
1a	Seal Beach	17 Oct	318	138	17 Oct	143	44.8%
1b	Seal Beach	17 Oct	405	129	17 Oct	138	34.1%
1c	Seal Beach	20 Oct	124	37			
2a	Tumbledown	24 Oct	1,001	143			
2b	Tumbledown	24 Oct	673	65			
3	Admirals	26 Oct	730	63	26 Oct	339	46.4%
4	The Glen	1 Nov	754	81			
5	Sophora Glen		(1,767)		1 Nov	738	
6	Cavern Head		(2,274)		8 Nov	950	
	Total		**7,866**			**Mean**	**41.8 ± 3.9%**

The figure in parentheses for Sophora Glen and Cavern Head are extrapolations from scan counts, assuming an average scan count underestimate of 41.8%.

Table 4.1.2: Ground counts of incubating rockhopper penguins and rockhopper penguin chicks, with estimated breeding success.

		Ground counts		Ground counts		
Site	**Location**	**Date**	**Incubating birds**	**Date**	**Large chicks**	**Breeding success**
1a	Seal Beach	17 Oct	318	10 Jan	101	31.8%
1b	Seal Beach	17 Oct	405	10 Jan	140	34.6%
1c	Seal Beach	20 Oct	124	10 Jan	47	37.9%
2a	Tumbledown	24 Oct	1001	10 Jan	426	42.6%
2b	Tumbledown	24 Oct	673	10 Jan	177	26.3%
3	Admirals	26 Oct	730	14 Jan	323	44.2%
5	Sophora Glen		(1,587)	8 Jan	575	
		Total	**7,866**		**Average**	**36.2 ± 2.8%**

The figure in parenthesis for Sophora Glen is an extrapolation, assuming a breeding success of 36.2%.

Discussion

Ground counts were the best means of estimating penguin numbers. Scan counts considerably underestimated the total number of breeding birds because the vegetated and rocky habitat hid many birds from sight. Ground counts caused some disturbance and disruption to the breeding colonies, which could be reduced by the observers walking close together and moving slowly and quietly through the colonies. Some incubating birds moved off their eggs when the observers were close, but were seen to return to the nest. No predation of eggs by skuas was observed during the colony counts, although some skuas needed to be scared away to allow the penguin to return in time. No attempt was made to repeat ground counts due to the disturbance involved in this method. However, the counts, particularly of incubating birds, are certain to be sufficiently accurate to detect the type of large-scale declines observed in other rockhopper penguin populations.

The relatively small coefficient of variation of scan counts, the small standard error for the underestimate made by scan counts, and the lack of significant between-observer differences, means that scan counts are suitable to allow relatively crude estimates of total breeding numbers when time or weather conditions prevent ground-counts from being made. Similarly, the similarity in breeding success between colonies means that the number of birds on eggs can be back-estimated for colonies where only counts of chicks were made. Using both these methods for Sophora Glen, which was scan-counted for incubating birds and ground counted for chicks, gives very similar estimates of the number of breeding pairs.

The patchy distribution of rockhopper penguin colonies and the limited number of sites counted during this study means that no new estimate can be made for the total Gough Island population. The most comprehensive rockhopper penguin survey was made in 1984, which from ground counts of 44% of the coastline and scan counts of the remainder, estimated a total of 144,235 pairs (Watkins 1987). The 1984 survey counted 733 and 1,379 incubating pairs at The Glen and Sophora Glen respectively (Watkins 1987). These counts are strikingly similar to the figures found by this study: 754 incubating pairs at The Glen and an estimated 1,550 to 1,800 pairs at Sophora Glen. These counts suggest that the population of rockhopper penguins on Gough Island has not decreased since the early 1980s, and the total population is still likely to be around 145,000 pairs.

Plate 4.1: Adult northern rockhopper penguin (photo: RW White).

4.2 Tristan albatross *Diomedea dabbenena*

Tristan albatrosses commence incubation in January, with chicks hatching in March and fledging in November/December. A whole-island count of incubating birds was conducted in January 2001. Whole-island counts of large chicks were conducted in September 2000 and 2001. Following Ryan *et al* (2001), Tristan albatrosses were counted by a combination of walking through breeding areas and scan counts from vantage points overlooking breeding colonies. Each river catchment was counted separately, with sketch maps being made of defined areas to ensure that birds were not double counted, and so that we could detect additional birds obscured from previous vantage points. The count route (Figure 4.2.1) followed that of Ryan *et al* (2001) and took around three days of good weather to complete. The whole island was not necessarily counted over three consecutive days, with bad weather during September 2001 meaning that the whole island was surveyed over a ten day period, with three separate trips into the hills needed to complete the count.

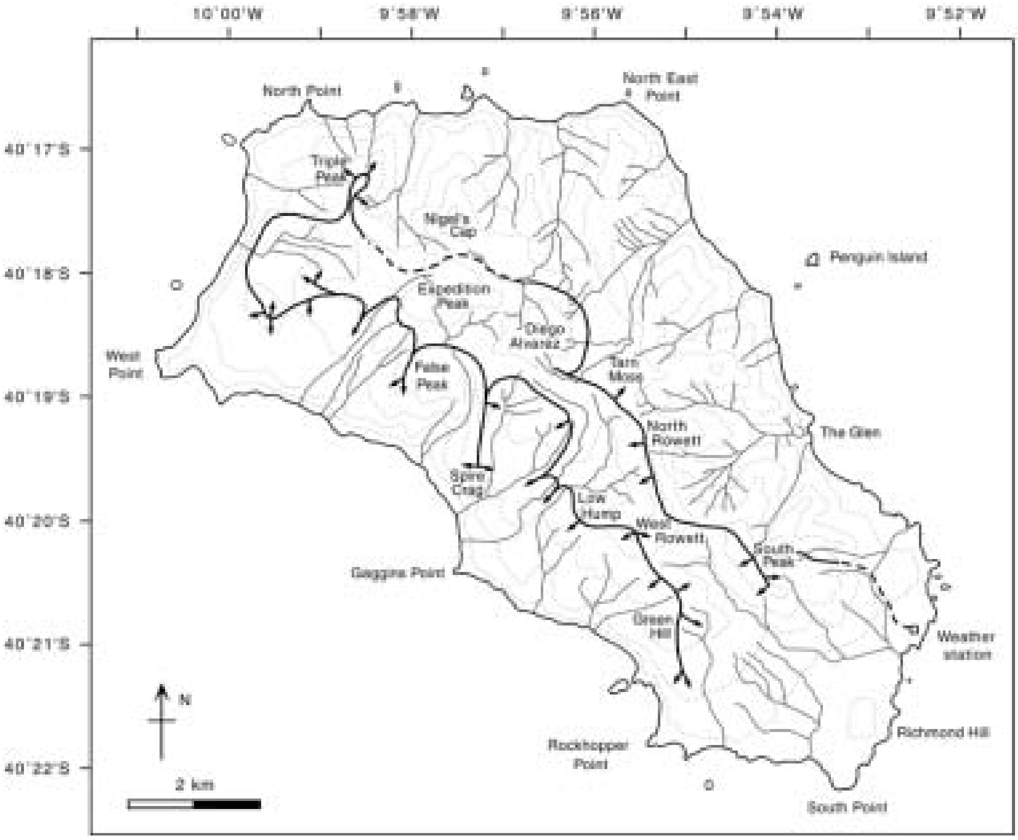

Figure 4.2.1: Route followed and vantage points for the island census of Tristan albatrosses.

Counts were made with 8x40 binoculars, with a tally kept on a mechanical counter. Usually two observers counted each area, with counts being repeated until the tallies agreed. When time or bad weather dictated, only one observer counted certain sections.

Counts of large chicks during September were relatively easy to complete as there are relatively few adults around, and chicks are still largely covered with white down and are easily detected with binoculars. Care was needed in some instances to separate large chicks from adult birds that were sitting in the colony, but the plumage and behaviour of adults usually made this relatively straightforward. Scan counts of incubating adults during January 2001 were of AONs. These counts were complicated by the relatively high density of nests (particularly in the West Point count section) and the need to distinguish incubating birds from non-breeding birds that were sitting in the colonies. The behaviour and posture of incubating birds could often be used to distinguish between breeders and non-breeders, with incubating birds not responding to other courting birds and acting aggressively towards skuas and southern giant petrels that approached the nest. To validate these counts, we completed ground counts of chicks and incubating birds in the Gonydale area. In January 2001 all nests were marked and sitting birds were checked for the presence of an egg. In September 2000 and 2001 all of the chicks in Gonydale were counted on foot and ringed.

Plate 4.2: Adult male Tristan albatross (*photo: RJ Cuthbert*).

Results

Scan counts and ground counts of large chicks in Gonydale produced identical numbers of chicks in both September 2000 and September 2001. Similarly, in September 1999 Ryan *et al* (2001) scan counted 73 chicks in Gonydale where previously they had counted 72 chicks on the ground. Scan counts of AONs and ground counts of Gonydale during January 2001 again produced very similar estimates, with 124 AONs and 125 birds actually recorded incubating eggs. These results indicate that scan counts produce reliable counts of chicks and incubating pairs.

The whole-island count in January 2001 recorded a population of 2,400 incubating pairs. Different count areas of Gough Island have very different numbers of birds, with, in particular, the West Point area holding over 900 pairs (Table 4.2.1). Whole-island counts of large chicks in September 2000 and September 2001 recorded 318 and 656 chicks respectively (Table 4.2.1). The approximate distribution of birds within the count areas is illustrated in figures of Appendix 3.2.

Table 4.2.1: Counts of Tristan albatrosses on Gough Island within the eight main count areas, and the whole-island count.

Area	1956 (adults)	1982 (chicks)	1999 (chicks)	2000 (chicks)	2001 (adults)	2001 (chicks)
Tafelkop	0	13	6	5	16	8
Green Hill and Gonydale	700	84	265	89	486	182
Albatross Plain	430	168	160	74	325	89
Spire Crag	35	113	224	19	338	128
False Peak	10	55	107	22	129	35
West Point	35	260	255	79	918	174
Triple Peak	16	68	70	15	153	27
Tarn Moss	0	37	42	15	35	13
Total	**1,226**	**798**	**1,129**	**318**	**2,400**	**656**

Discussion

Scan counts and ground counts are a reliable means of censusing Tristan albatrosses, with both methods providing very similar counts. The major factor determining the repeatability of counts is ensuring that the whole island is completely covered. The route-map (Figure 4.2.1) should ensure that this is the case. If the whole island cannot be counted (eg because of bad weather during the takeover period), then observers should ensure that for the count areas covered, each area is fully counted. If counts do need to be restricted then the priority count areas would be Green Hill and Gonydale, Albatross Plain and Tafelkop. These are the areas where most previous effort has been directed.

The whole-island count in 2001 recorded a population of 2,400 incubating pairs: a similar figure to the 'around 2,000 pairs', reported from 1956 (Swales 1965). It is unknown how extensive or thorough this earlier count was. The 1956 team counted a total of 1,130 incubating pairs in the Gonydale, Green Hill and Albatross Plain areas (where ornithological research was concentrated in 1956). These three areas normally hold around 38.4% of the total island population. If 1956 was a 'typical' breeding season and the distribution of breeding birds was the same as it is now (but see Ryan *et al* 2001), then the population in 1956 may have been closer to 3,000 pairs (1,130/0.384 = 2,942) than the estimate of around 2,000. Restricting the analysis to the areas of Gonydale, Green Hill and Albatross Plain, 811 incubating adults were counted in the 2001 season in comparison to 1,130 adults in 1956: suggesting a population decrease in these areas of 28%, equivalent to 0.72% per year. Whole-island counts of near-fledging-age chicks over three successive breeding seasons (1999, 2000, 2001) give an average of 705 chicks with considerable between-year variation (Table 4.2.1). Comparing the average number of chicks counted in 1979 and 1982 (792 and 798 chicks respectively) with the average number recorded from 1999 to 2001 (705 chicks), again suggests that the population has decreased over this 20-year period at an annual rate of 0.63%, although this conclusion is tentative, due to the annual variation in chick numbers.

Estimating the total population of Tristan albatrosses is difficult because of the high between-year variability in chick counts and uncertainty over the 'normal' breeding success of this species (Cuthbert *et al* in press). The very low numbers of chicks fledging in the 2000 season may be a result of low numbers of adults attempting to breed and/or low breeding success. However, both scenarios would have led to an inflated number of breeding adults in the 2001 season and hence the total of 2,400 incubating pairs is likely to exceed the normal demi-population size. On average the annual breeding population forms around 59% of the total breeding population, and non-breeding juveniles and immature birds comprise 82% of the total number of birds (Weimerskirch *et al* 1997). Assuming that the demi-population lies between 1,500 (Ryan *et al* 2001) and 2,400 pairs (this study), then the total current population of Tristan albatrosses is likely to be within the range of 9,250 and 14,800 birds.

4.3 Atlantic yellow-nosed albatross *Thalassarche chlororhynchos*

Atlantic yellow-nosed albatrosses were censused through ground counts of 11 defined areas. The counts were conducted between 11 October and 8 November 2000. The eleven count areas were mainly located in the south-east of Gough Island from Richmond Hill to the ‘Serengeti’ (the area between Tafelkop, South Hill and Sophora Glen, see Fig 2.1). Two observers were needed to count each area, with all nests being checked for the presence of an incubating bird. The number of empty nests and loafing birds was also recorded. Each count area was walked in a number of transects, with the edge of each transect being periodically marked with bright spray paint. In this way, when the next transect returned across the study area the boundary of the last transect was clearly defined, thus avoiding double counting any birds. The boundary of each count area was mapped using handheld GPS devices, and each count area was mapped, its area measured and the density of incubating birds calculated. A habitat map of Gough Island enabled the total area of fernbush habitat to be estimated (the area where Atlantic yellow-nosed albatrosses are found), and consequently enabled the total population to be extrapolated.

Annual counts of one study area on Gough Island have been made since 1982. We used the count data from this area to investigate trends in the Gough Island population. The data from this area were also used to predict the power of the established monitoring protocol to detect different rates of decline. The residuals in the count data for the fitted regression line of Figure 4.3.1 (for the periods 1982 to 1995 and 1996 to 2001) were used to estimate the annual variance of the population around a given trajectory. This variance was used to simulate annual counts in a population with rates of decrease of 1% and 2.5%. One thousand simulations were run for each rate of decrease. The subsequent pooled regression was used to test the significance of the decline in the resulting data, using a total of 1, 4, 8, and 12 independent count areas, and after a time period of 5, 10, … to 40 years. The proportion of significant results (using a one-tailed test and $p < 0.05$) from each 1,000 runs was used to calculate the power of each monitoring scheme.

Results

A total of 538 incubating yellow-nosed albatrosses were counted within the 11 count areas (Table 4.3.1). There was considerable variation in density of breeding birds, ranging from 113.7 – 1,122.5 pairs km^{-2}. The mean estimated density of birds was 504.0 pairs km^{-2} (S.E. = 96.4; 95% C.I. 289.3 – 718.7 pairs km^{-2}). The nine surveyed areas covered a total of 1.1 km^2, approximately 11% of the estimated 10.4 km^2 of fernbush habitat. Using this area estimate the breeding population of Atlantic yellow-nosed albatrosses is estimated to be 5,260 pairs (95% C.I. 3,020 – 7,500 pairs).

Plate 4.3: Incubating Atlantic yellow-nosed albatross (*photo: RW White*).

Table 4.3.1: Ground counts of incubating birds, birds on empty nests and loafing Atlantic yellow-nosed albatross at sites on Gough Island during the 2000/2001 breeding season, with area and density estimates, total count and mean density.

Site	Area (km^2)	Date counted	Birds on eggs	Birds on empty nests	Loafing birds	Incubating pairs km^{-2}
1	0.04	11-Oct-00	39	11	9	975.0
2	0.14	11-Oct-00	59	6	8	430.5
3	0.08	11-Oct-00	33	8	2	405.0
4	0.16	12-Oct-00	93	18	14	583.9
5	0.07	16-Oct-00	8	2	2	113.7
6	0.09	24-Oct-00	21	2	1	246.5
7	0.07	18-Oct-00	28	3	3	420.0
8	0.12	17-Oct-00	43	12	10	351.8
9	0.22	28-Oct-00	40	16	6	183.0
10	0.13	05-Nov-00	95	42	26	712.4
11	0.07	08-Nov-00	79	17	32	1122.5
Total	**1.14**		**538**	**137**	**113**	**504.0 ∂ 96.4**

The number of breeding birds within the monitored study colony on Gough Island has been variable over the study period (Figure 4.3.1), with an average of 46.7 ∂ 11.0 incubating pairs (CV = 23.5%) found in Area 1. There was a significant decrease in breeding numbers from 1982 to 1995 (regression slope = -1.60 (S.E. = 0.73), $F_{1,13} = 4.81$, $p < 0.05$) with the colony decreasing at an average rate of 3.2% year^{-1} during this period. Since 1995 the numbers of breeding birds has increased at an annual rate of 6.7% (regression slope = 3.36 (S.E. = 1.12), $F_{1,6} = 8.96$, $p < 0.05$). Over the whole study period (1982 to 2001) there has been an annual decrease in breeding numbers of 1.1% (Figure 4.3.2), although this decline is not statistically significant (regression slope = -0.56 (S.E. = 0.42), $F_{1,19} = 1.90$, $p = 0.20$). The simulated populations reveal the limited power of monitoring just one study area (Figure 4.3.2). The ability to detect declines increases greatly when more sites are counted (Figure 4.3.3). If the population is decreasing at around 1% year^{-1}, then with 8 – 12 count sites it may take around 20 – 25 years of 5-yearly monitoring to detect such a trend with statistical power of 0.8 (a generally accepted norm). If the population is actually decreasing at closer to 2.5% year^{-1}, then it may only take 10 – 15 years of monitoring to detect the trend reliably (Figure 4.3.3).

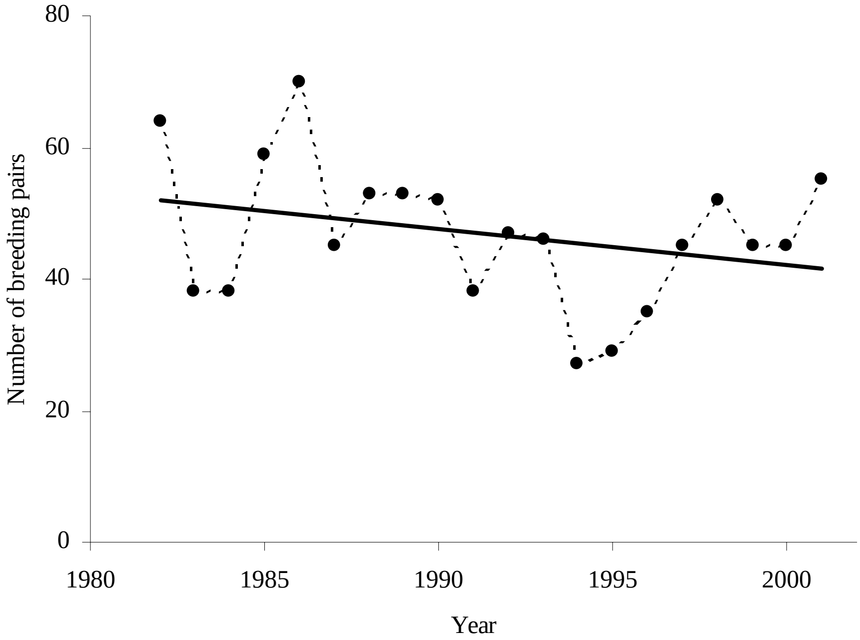

Figure 4.3.1: Number of incubating Atlantic yellow-nosed albatrosses in the monitored study colony on Gough Island from 1982–2001. The heavy solid line is the linear regression best-fit line, which predicts an annual rate of decrease of 1.1%.

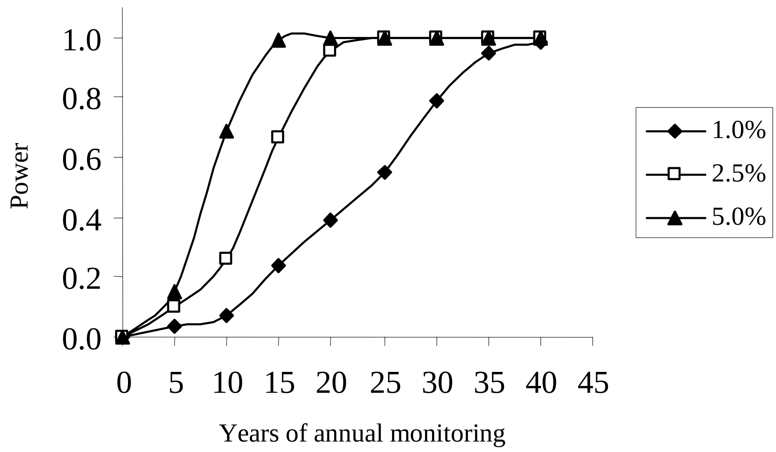

Figure 4.3.2: Power to detect population decreases as a function of time, at annual decline rates of 1%, 2.5% and 5% with one site monitored at yearly intervals.

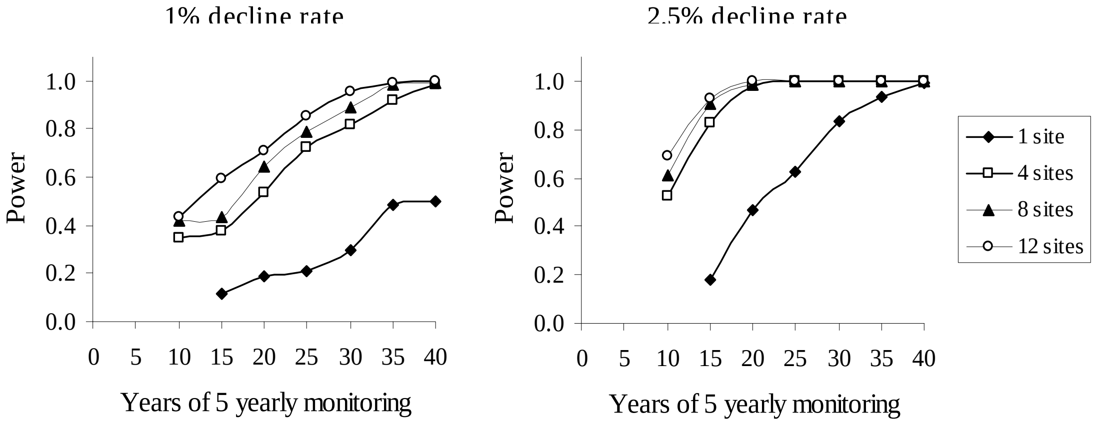

Figure 4.3.3: Power to detect population decreases as a function of time, at annual rates of 1% and 2.5%, with 1, 4, 8 and 12 sites monitored at 5-yearly intervals.

Discussion

Extrapolation from ground counts of c 10% of the available breeding habitat on Gough Island indicates a total breeding population of around 5,250 incubating pairs in the 2000/2001 breeding season (Cuthbert *et al* 2003). This estimate is similar to the 'at least 5,000 to 10,000 pairs' reported by Richardson (1984) for 1972. However, this latter figure was based on a very short visit to Gough Island (*ca* 5 days) and cannot be used as the basis for assuming any population trend since then. Limited data are available from the other islands in the Tristan da Cunha group, although there is an indication that numbers of breeding birds may have decreased since the late 1980s at Inaccessible Island (Ryan & Moloney 2000). The population trends found in this study suggest that numbers of breeding birds have decreased at an annual rate of 1.1%, and similar trends are found for a study colony monitored at Tristan da Cunha (Cuthbert *et al* 2003). Neither of these trends is statistically significant, but the power to detect such a decline with only one monitored population is poor. Further examination of the numbers of established breeders and recruits at Gough Island suggests that numbers of established breeders are decreasing at around 2.3% a year, and that annual variation in breeding numbers and recruitment of new birds into the study population is masking this underlying trend (Cuthbert *et al* 2003). The suggestion of a decreasing population is supported by population modelling using demographic parameters measured at the Gough Island study colony. The model predicts an annual decrease of around 1.2% for the total population and 2.8% for the breeding population (Cuthbert *et al* 2003).

4.4 Sooty albatross *Phoebetria fusca*

Sooty albatrosses were censused through scan counts of breeding areas located along the coastal and inland cliffs of Gough Island. Fourteen areas were counted: 10 coastal and four inland cliffs (see supplementary PowerPoint presentation). All areas were counted during late October and early November, when birds were incubating. The count unit was the AON, determined by the posture of birds sitting stationary on nests. Loafing birds were also counted. Four areas were re-counted in mid- to late February, when large near-fledged chicks were present; this allowed an estimate of overall breeding success. All areas were scanned with binoculars during times of the day when the light was most suitable for viewing the area.

The length of all scanned coastal cliffs and the total perimeter of Gough Island was measured from a large-scale map and using the 'Canvas' drawing program. The length of each scanned section and the total coastline was measured three times, and the mean was used in the final analysis. These lengths were used to estimate the linear density of coastal breeding sooty albatrosses and to estimate the coastal population size. Estimating the density and population size of birds breeding on inland areas of Gough Island was difficult because the inland count areas are not well defined on the map, and suitable inland breeding sites are distributed patchily across the island. The total available inland habitat is unknown.

Plate 4.4: Incubating sooty albatross (*photo: RJ Cuthbert*).

Results

A total of 223 incubating birds were counted, with 145 counted on sea cliffs and 78 on inland cliffs (Table 4.4.1). The coastal count comprised 6.2% of the estimated total coastline. Relatively few birds were recorded in each count area with an average of 13.7 (SE. = 6.7) birds in each site. Non-breeding birds were also rare, forming just 17.5% of the observations. Four areas were re-counted during late February when large chicks were present. The mean breeding success at these four sites was 53.7% (36/57, 95% CI = 41.1 - 66.0%).

Sooty albatross density (pairs km^{-1}) in coastal areas varied greatly (Table 4.4.1), with an overall mean of 62.2 (S.E. 11.8 birds km^{-1}, n = 10 count areas, 95% C I = 35.6 - 88.8 birds km^{-1}). The 10 areas of coastal cliff covered an estimated linear length of 2.59 km. If the observed mean density is representative of the rest of the island, then the total population breeding on 42.1 km of coastline would be 2,620 pairs (95% CI = 1,500 - 3,740 pairs). Breeding sooty albatrosses were not observed in great numbers on inland cliffs of Gough Island, and the total island population is likely to be no greater than 5,000 pairs.

Table 4.4.1: Coastal and inland count areas of sooty albatrosses, length of coastal cliff counted, number and density of incubating pairs, loafing birds and chicks.

Area	Habitat	Length (km)	Date counted	Incubating pairs	Incubating pairs km^{-1}	Loafing birds	Large chicks
1	Coastal	0.13	13/10/00	9	67.5	3	
2	Coastal	0.21	13/10/00	4	18.8	0	
3	Coastal	0.15	13/10/00	20	136.4	7	
4	Coastal	0.39	13/10/00	27	69.8	5	10
5	Coastal	0.19	13/10/00	18	96.4	1	8
6	Coastal	0.21	16/10/00	6	28.1	1	
7	Coastal	0.21	25/10/00	17	79.7	3	
8	Coastal	0.27	26/10/00	15	56.3	2	
9	Coastal	0.43	8/11/00	23	53.9	5	
10	Coastal	0.40	18/10/00	6	12.5	3	3
11	Inland		27/10/00	13		3	
12	Inland		27/10/00	10		3	
13	Inland		27/10/00	15		1	
14	Inland		3/11/00	16		1	15

Discussion

Scan counts of breeding areas are the only feasible method for repeatable counts of breeding sooty albatrosses and this method has been used in other studies (eg Moore 1996). Good light conditions were essential for observing the nests of breeding birds, and surveys must be done at times of the day when the cliffs are not in shade. The accuracy of scan counts of the cliffs on Gough Island cannot realistically be tested as there is no way to access the cliffs on foot and ground-truth them. Counts at Macquarie Island indicate that scan counts are likely to underestimate the true numbers of nests (Disney 1995, in Moore 1996), and it is likely that the counts from Gough Island are also underestimates. While this is not ideal, the counts will still provide a repeatable means of counting breeding sooty albatrosses that should detect a major change in abundance.

The estimated current population of around 5,000 pairs is similar to Richardson's 1972 estimate of '5,000 to 10,000 pairs' (Richardson 1984). Richardson counted 650 incubating pairs along the coastal cliffs from Standoff Rock to The Admiral. This area covers 2.3 km of coastline (measured using the 'Canvas' drawing program) – c 5% of the island's coast (Richardson 1984), and hence had a density of 152.6 birds km^{-1} in 1972, over twice the mean density of birds breeding in the 2000 season (62.2 ∂ 11.8). Four count areas (areas 1 to 4) from the 2000 season were within the coastal area that Richardson counted, and the mean density of birds in these areas (58.8, SE 28.6) is very close to the mean density recorded at all coastal sites in 2000. If the density of birds counted in 1972 was typical of the whole island (as it appeared to be in 2000), then the coastal population may have been around 6,425 pairs in comparison to the current estimate of 2,620 pairs. This represents a decline of nearly 60% over 28 years, with an annual rate of decrease of 3.2%. If the annual variability in the number of breeding sooty albatrosses is similar to the variation observed for Atlantic yellow-nosed albatrosses, then with a decline rate of 3.2% and ten monitored sites the monitoring scheme should reliably detect such a decrease after 10–15 years (Figure 4.3.3).

The reliability of these results depends on the between-year variability in breeding numbers and the accuracy of counts. Further counts are needed to assess the current variation in the annual breeding population, but it seems unlikely that breeding numbers could fluctuate so greatly as to undermine the evidence for a decrease in numbers. The reliability of Richardson's count is unknown; however, despite the brevity of his trip, several days were spent on boats around Gough Island, and this time should have given a good chance to obtain reliable count data for this species. Moreover, the scan counts undertaken by Richardson are most likely to underestimate rather than overestimate breeding numbers, and there is no reason to expect the 1972 counts to have detected a higher proportion of breeding pairs than the 2000 count.

The apparent decline rate found on Gough Island corresponds closely to the decrease in numbers on Marion Island, where the population has decreased by 25% over 8 seasons, at an annual decline rate of 3.1% (Nel et al. 2002). The only other data on sooty albatross numbers comes from Possession Island, where numbers have declined at 6.9% year^{-1} over a 30-year period (1966–1995) (Weimerskirch & Jouventin 1998). Together, these two studies and the apparent decrease that is indicated for Gough Island suggest that there has been a major fall in the global population of sooty albatrosses over the last 30 years.

4.5 Southern giant-petrel *Macronectes giganteus*

Southern giant petrels are known to breed in only three areas of Gough Island. These areas are located below Low Hump on the west of the island, in the valley to the south of Triple Peak at the far north end of Gough Island, and along the eastern coast from The Glen to Long Beach (Swales 1965; Shaughnessy & Fairall 1976; Williams 1982; Figure 4.5.1). Chicks of southern giant petrels were found in late November and December of the 2000 season, and some birds had started incubating during late August of the 2001 season. This allowed a total count of the two known inland breeding sites to be made during September 2001. Unfortunately, incubating birds were not counted during the 2000 season. Due to the difficulty of access, the coastal areas on the east of Gough Island were not counted at any stage. However, only one or two pairs have ever been recorded from these areas (Shaughnessy & Fairall 1976).

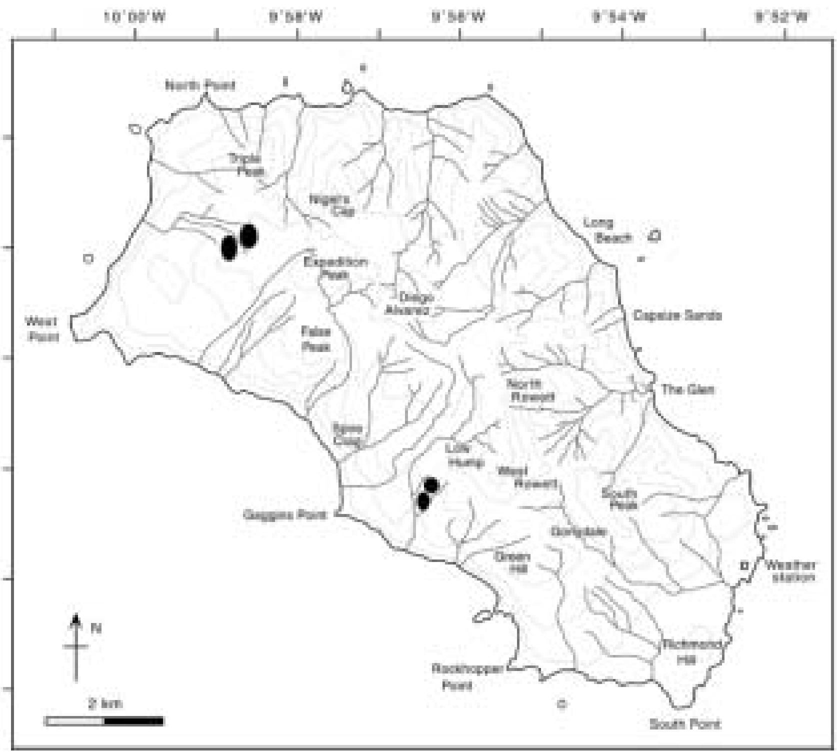

Figure 4.5.1: Location of the main breeding colonies of southern giant-petrels on Gough Island, to the south-west of Low Hump and to the south of Triple Peak (indicated by black ovals). Small numbers of breeding birds have also been recorded along the east coast from The Glen to Long Beach.

Results

One section of the Low Hump colony was scan counted and subsequently counted on foot, with totals of 70 and 100 incubating birds recorded respectively, indicating that scan counts of this area are likely to underestimate the true figure by around 30%. A ground count of the whole of the Low Hump colony in September 2001 found 169 occupied nests and one nest with the remains of a broken egg. A scan count of the Triple Peak colony recorded a total of 57 AONs. Assuming that this count underestimated the true figure by 30%, there may have been around 74 incubating birds in the area.

Plate 4.5: Adult southern giant petrel (*photo: PG Ryan*).

Discussion

Counts of southern giant petrels are relatively simple due to the presence of only two major breeding colonies. The inland breeding colonies of southern giant petrels should be counted during the incubation period and this could easily be done during the takeover period. The northern Triple Peak site can be counted during a census of Tristan albatrosses, although this does require decent weather and at least one hour of extra counting time. The Low Hump site can be counted in 3-4 hours and this can be completed in a day from base or combined with the Tristan albatross count. Some care is needed with ground counts of southern giant petrels, as some incubating birds moved away from their eggs and disturbance can be a major cause of nesting failure in this species. Most birds remained sitting tight initially, but were noticeably more nervous when we walked back through them to check birds for rings. Counts should be completed once, and observers should not disturb incubating birds any more than necessary.

The current breeding population of southern giant petrels is estimated to be around 225–245 breeding pairs. This estimate is considerably higher than previous counts from Gough Island, with 60 newly hatched young counted at Low Hump in December 1959 (Swales 1965) and 44 nests (five empty, three with eggs, 36 with chicks) at Low Hump in November 1979 (Williams 1982). Williams (1982) counted just five nests (four chicks and one empty nest) in the Triple Peak colony in 1979. Even with failures during the course of breeding (estimated at 29.5% for southern giant petrels on South Georgia; Hunter 1984), these results suggest a substantial recent increase in numbers. The increased numbers of southern giant petrels may be attributable to increased survey effort or to a genuine increase in numbers. During 2001, PG Ryan was confident that birds nesting in the Low Hump colony had expanded into new areas since his visit in 1990. The documented increase in subantarctic fur seal numbers *Arctocephalus tropicalis* on Gough Island (Bester 1990) might explain an increase in the southern giant petrel population, as seals provide a major source of food for the species (Hunter 1984).

4.6 Atlantic petrel *Pterodroma incerta*

Permanent quadrats were established along three separate transects to monitor Atlantic petrels. These three transects were all sited in areas of fernbush habitat, which supports the highest densities of Atlantic petrel burrows. Additionally, the soil and vegetation in areas of fernbush is less prone to erosion than coastal tussock habitat (the other area where Atlantic petrels are found), and consequently observer-damage to burrows in long-term monitoring plots will be less likely in the chosen areas. The three transects were sited in the south-east of the island, where most fernbush habitat occurs, at altitudes of 50 to 250 m asl (see Appendix 3.3). Forty-three quadrats measuring 8 x 8 m were distributed along the three 120 m transects in a chequer board pattern either side of the main transect line. Each transect line is marked with numbered bamboo/fibre-glass poles positioned every 8 m.

Within each quadrat, we counted the total number of Atlantic petrel sized burrows, as well as the number of other burrows (mainly belonging to soft-plumaged petrels and great shearwaters). Burrows were assigned to species on the basis of the average dimensions of occupied study burrows for each species (Figure 4.6.1).

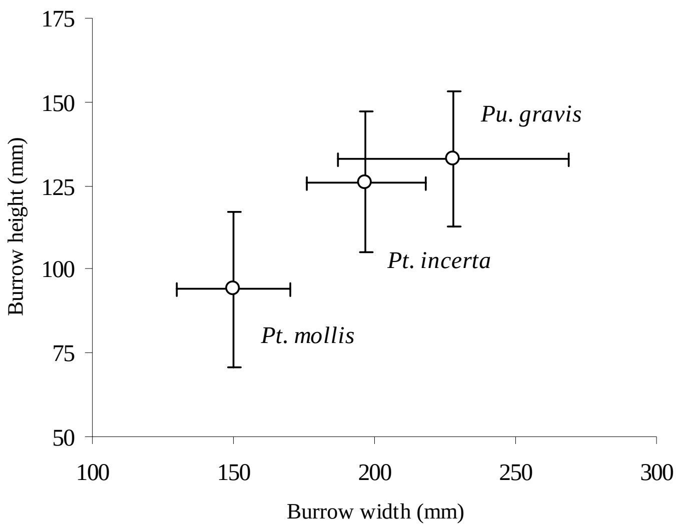

Figure 4.6.1: Average burrow dimensions of Atlantic petrels *Pterodroma incerta*, soft-plumaged petrels *Pterodroma mollis* and great shearwaters *Puffinus gravis*. Error bars represent one standard deviation.

While there was some overlap in size between Atlantic petrel and great shearwater burrows, Atlantic petrel burrows were significantly narrower ($t_{2,64} = 3.80$, $p < 0.001$), but with no significant difference in height ($t_{2,64} = 1.45$, N.S.). Rather than measuring each burrow entrance within the quadrat, we cut wooden crosses to the average width and height of Atlantic petrel (197 x 126 mm respectively), great shearwater (228 x 133 mm) and soft-plumaged petrel (150 x 94 mm) burrows. In this way, the species most likely to be occupying each burrow could be swiftly determined. Only burrows that extended beyond the length of the observer's forearm (approximately 0.4 m) were counted. Burrows that had two entrances that obviously connected were counted as one burrow. Burrows on the edge of each quadrat were recorded if more than half of the entrance lay within the quadrat. When counting each quadrat, the area was split into two 8 m x 4 m sections, temporarily marked with bamboo poles. Both observers worked side by side searching a 2 m strip within the 8 x 4 m section, with each observer proceeding slowly on hands and knees and looking for burrows under and within all vegetation. Working in this manner ensured that all burrows were found and none were counted twice. The same procedure was repeated for the remaining 8 m x 4 m section of the quadrat. Counting burrows and scoring burrow sign (see below) within each quadrat took approximately one hour of mental anguish.

In order to monitor Atlantic petrels with more precision it is necessary to estimate the proportion of ‘active burrows’ as well as the density of burrows within each quadrat. An ‘active burrow’ may contain an incubating or non-breeding bird, and this classification is not a surrogate for ‘burrow occupancy’ which should be estimated from the proportion of burrows known to contain an incubating bird (either measured from a sample of study burrows or using a burrowscope; Cuthbert & Davis 2002). The activity status of each burrow was assessed using a combination of tape playback and different field-signs present or absent at the burrow entrance. At each burrow entrance we played the call of an Atlantic petrel (lasting approximately six seconds) with a small portable cassette recorder, and after an interval of 10 seconds this call was replayed down the burrow. After waiting for another 10–15 seconds we recorded whether a bird responded or not to the call. Rather than just describing burrows as ‘active-looking’ or ‘apparently active’ (which is subjective and inaccurate; Cuthbert & Davis 2002) we used four categorical variables to describe the burrow entrance. These signs were: (1) ‘digging’ (with large amounts of soil scattered outside the burrow entrance), (2) ‘disturbance’ (claw marks on the burrow floor and/or tunnel swept clean with small amounts of freshly disturbed soil), (3) ‘fresh vegetation’ (green plant matter within the tunnel often covered with particles of soil) and (4) ‘blocked’ (burrow entrance more than half full of soil or compacted vegetation). Three other signs were originally selected (‘cobwebs’, ‘feathers’ and ‘guano’ within the burrow entrance), but they occurred so infrequently as to make analysis meaningless.

The accuracy of these methods at determining whether a burrow was active or not was tested from a sample of study burrows where the status of the burrow could be determined absolutely through a hatch dug above the nesting chamber. At each burrow entrance we recorded the presence or absence of the four field-signs and then played the taped call two times at the entrance. The burrow was then opened to check on its status. This procedure was completed on 15 July 2001 during the first month of incubation (n = 58 burrows), and was later repeated on 25 September during early chick-rearing (n = 51 burrows). During incubation, an active burrow was defined as ‘a -burrow containing either an incubating bird or a non-breeding bird’, during the chick period we defined an active burrow as ‘a burrow containing a chick or a non-breeding or failed breeding bird’. Again, it is important to note that these definitions refer to the activity status of the burrow, and this is not the same as determining whether the burrow contains an incubating pair or a chick. Between-observer differences in scoring burrow sign were tested by both observers independently scoring burrows within two quadrats. Burrows within the 43 quadrats were all counted and scored from 18 July –6 August 2001, during the early stage of incubation (egg laying occurred from 15 June–21st July 2001, with a median laying date of 29 June).

To produce a population estimate of the Atlantic petrel it was necessary to determine the area of Gough Island occupied by the species, the density of burrows within these areas, and the proportion of burrows actually occupied by breeding pairs. The total population was estimated as: proportion of burrows that are occupied by a breeding pair x (habitat specific) burrow density x area occupied by each habitat type. Because field signs cannot distinguish accurately between burrows occupied by a breeding pair versus non-breeders, we estimated burrow occupancy of breeders from a sample of 64 study burrows fitted with a hatch above the nesting chamber, that were dug during September 2000 and April 2001. Burrow occupancy was estimated from the proportion of study burrows that contained an incubating pair at the start of the 2001 season. Initial information on the distribution of birds was determined by the recovery of petrel carcasses that had been killed by subantarctic skuas, and was later corroborated by the underground calling of birds during the courtship and incubation periods. Burrow density was estimated from the 43 permanent quadrats and from another 23 quadrats randomly distributed within the coastal tussock habitat. Burrow count data followed a Poisson distribution and these data were square root transformed before statistical analysis.

Results

A sample of 58 study burrows was used to test the accuracy of sign and playback at determining the activity status of burrows. Of 30 birds on eggs, 20 responded to playback (66.7% 95% CI = 47.2 – 82.7%) with only 1/6 non-incubating birds responding. Overall response to tape playback correctly classified the occupancy status of 43/58 study burrows (71.1%, 95% CI = 61.0 – 84.7%). Using signs at the burrow entrance as well as playback classified more burrows correctly. We assigned a score of +1 for each sign indicating activity (response to playback, disturbance, fresh vegetation, no digging and no blockage), and a score of zero to sign indicating no activity (no response, no disturbance, no fresh vegetation, digging and blockage). The best predictor of activity during the incubation period was provided by a total score of 4 and above, which correctly classified 86.2% (95% CI = 74.6 – 93.9%) of burrows for observer 1, and 91.4% (95% CI = 81.0 – 97.1%) of burrows for observer 2 (with observers scoring the sign independently). While there were some differences in the status of sign at each burrow entrance, there was good agreement between the total scores (provided by all four signs and tape playback), with the activity status agreeing in 87/89 (97.8%) of burrows scored by both observers during incubation. These methods were repeated on a sample of 51 burrows at the end of September, during the early stages of chick-rearing. No chicks (n = 14) responded to tape-playback. Using the four burrow entrance signs (and a score of ä4 as the threshold for assigning activity), did not provide an accurate classification of whether a burrow was active or not at this time (observer 1 = 49% correct, observer 2 = 58.8% correct), nor whether the burrow was originally defined as active during the incubation period (observer 1 = 58.8% correct, observer 2 = 61.5% correct). No other combination of signs provided a better indication of the activity status of burrows at this time.

The total numbers of burrows, number of apparently active burrows and numbers of burrows where a bird responded to playback is presented in Appendix 3.3. A total of 663 Atlantic petrel burrows were counted and scored within the 43 quadrats, with an average of 14.8 (S.E = 0.05, range 2 – 29) burrows quadrat^{-1}. 223 birds responded to tape playback, giving a burrow response of 31.8% (with binomial 95% CI = 28.3 – 35.5%). 279 of the 663 burrows (42.1%, 95% CI = 38.3 – 45.9%) were classified as active on the basis of the four signs and response to playback.

Burrow density of Atlantic petrels in fernbush habitat was almost double that found in areas of coastal tussock (fernbush mean density = 0.23 burrows m^{-2}, SE = 0.05, n = 43 quadrats; coastal tussock mean density = 0.11 burrows m^{-2}, SE = 0.04, n = 27 quadrats); ($t_{2,68}$ = 5.84, p < 0.001). Habitat mapping indicated that there is 4.6 km^2 of coastal tussock and 10.4 km^2 of fernbush habitat on Gough Island. Using these area estimates, the burrow density estimates for each habitat and the proportion of burrows occupied by an incubating bird (59.4% = 38/64 study burrows occupied by an incubating pair in the 2001 season), the total population of Atlantic petrels is estimated to be 1,720,000 pairs (95% CI = 1,340,000 – 2,070,000 pairs).

Discussion

Monitoring burrowing petrels is difficult, and the Atlantic petrel proves no exception. Counting burrows is both laborious and tedious, and without digging study burrows the accuracy of determining the contents of a burrow is generally low (Cuthbert & Davis 2002). This study suggests that during early incubation a combination of field signs and the response of birds to tape-playback may be fairly accurate at determining whether a burrow was active or not, with these methods correctly classifying 86.2 – 91.4% of burrows. Moreover there was good agreement between observers (97.8%) for this method. Unfortunately, in late September the methods proved poor at determining the activity status of burrows (49.0 – 58.8% correct), or whether the burrow had been active during incubation (58.8– 61.5% correct). These results are regrettable if future monitoring cannot be completed during the incubation period.

While crude, simply monitoring the number of burrows within each quadrat should in itself provide a relatively good means of monitoring Atlantic petrels. Because of the rapid growth of vegetation on Gough Island and the digging activities of other burrowing petrels, any burrow that is disused is likely to become filled in and destroyed (Cuthbert 2001). As a consequence of this high turnover rate of burrows, the number of burrows will likely reflect large-scale trends in the population (Cuthbert 2001). Because the number of burrows is known for each quadrat, a paired analysis of burrow numbers should provide a powerful assessment of trends in burrow numbers. If the activity status of burrows can be assessed during incubation, then the proportion of active burrows and the number of burrows should be a able to detect large-scale changes in the population of Atlantic petrels.

These methods cannot accurately detect whether burrows are occupied by breeding pairs or chicks, and if this data were required then a sample of study burrows should be dug. Alternatively, using an infra-red burrowscope (Dyer & Hill 1991; Lyver *et al* 1998) may provide an accurate assessment of burrow occupancy. The simple structure of most Atlantic petrel burrows means that this method may be relatively accurate, despite the problems involved with using burrowscopes (Hamilton 2000; Cuthbert & Davis 2002). The estimated population of 1.7 million pairs makes the Atlantic petrel one of the most abundant burrowing petrels on Gough Island (Table 3.3). This estimate is considerably greater than the 'at least 20,000 pairs' reported in a recent review of its conservation status (BirdLife International 2000), and is in agreement with the rough estimates of Richardson (1984). We have no knowledge of population trends of Atlantic petrels, however simple population modelling suggests that with the observed levels of breeding success and mouse *Mus musculus* predation, the population may be decreasing (Cuthbert in press).

4.7 Gough moorhen *Gallinula comeri*

Monitoring Gough moorhens is difficult due to the cryptic behaviour of this species, which only occurs in the heavily vegetated lowland tussock and fernbush habitats of Gough Island. A variety of methods were tried, in an attempt to provide a reliable and robust method for monitoring the species. These methods include mapping sightings and calls of birds (Watkins & Furness 1986), tape-playback of territorial calls, and searching for nests. None of these methods provided a satisfactory monitoring protocol, as birds did not respond to playback of calls and nests were extremely difficult to find (and birds appear to build several nests which they then do not use). We also considered territory-mapping to be an unreliable method (cf Watkins & Furness 1986), because both sexes independently give a display call making it difficult to map a pair's territory. Additionally it was impossible to follow the movements of birds through the dense vegetation, so individual birds could not be followed to map their movements.

Plate 4.7: Gough moorhen (*photo: PG Ryan*).

In the end, Gough moorhens were monitored through 5-minute point counts repeated at monthly intervals from January–September 2001. Point counts were undertaken at approximately 200 m intervals (measured by pacing) along the coastal path from Tumbledown Beach to the Admirals (nine sites, primarily in coastal tussock habitat), and on the path from the Base to Tafelkop (10 sites, in fernbush habitat). At each site, we waited for 2–3 minutes after arrival to allow birds to resume their normal activities. For each minute of the 5-minute count period we recorded the number of territorial calls and contact calls. The loud territorial or display call 'check-a-kek' is an obvious sound within the lowland areas of Gough Island, and birds around the base can be heard giving this call. The contact call is a quieter and repeated 'kek-kek-kek…' and again this call can be heard from birds around the Base. Counting calls was relatively straightforward, but had to be undertaken on days with no or little wind and sites needed to be located away from streams. Where possible, counts along each path were undertaken and completed on the same day, but in some instances weather or other work commitments meant that counts were done over several days or that not all points could be surveyed. The average calling rate (calls/minute) at each site was the unit of replication in all the analysis.

Results

There were no systematic between-observer differences in the numbers of territorial calls counted during point counts undertaken at the same time (paired t-test, $t_{0.05,49} = 1.31$, n.s.), nor was there any systematic between-observer difference in the number of contact calls detected (paired t-test, $t_{0.05,49} = 1.00$, n.s.). The average territorial call frequency of birds was significantly higher in fernbush habitat (along the Tafelkop path) than in lowland coastal tussock habitat (fernbush 7.8 (SE = 4.6) calls min^{-1}, coastal tussock 5.8 (SE = 3.7) calls min^{-1}, t-test, $t_{0.05,147} = 2.83$, $p < 0.01$). The average frequency of contact calls was very low, at just 0.4 (SE = 0.5) and 0.5 (SE = 0.6) calls min^{-1} in fernbush and coastal tussock habitats respectively.

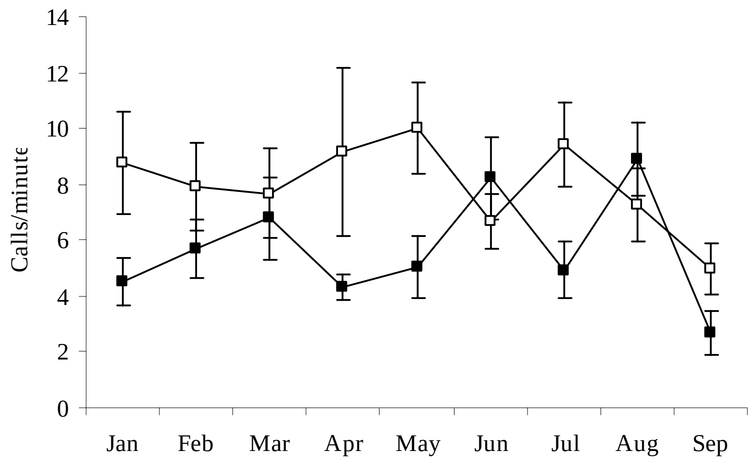

Figure 4.7.1: Monthly frequency (mean ∂ SE) of territorial Gough moorhen calls in coastal tussock habitat (filled squares) and fernbush habitat (open squares).

Average calling frequency of birds between months was variable (Figure 4.7.1), with CV = 35.8% and 19.9% for coastal tussock and fernbush habitats respectively (CV corrected for small sample size and estimated from the mean of each monthly census). There were significant between-month differences in the frequency of territorial calls for point counts on the lowland Tumbledown to Admirals path (ANOVA, $F_{8,65} = 2.67$, $p < 0.02$), but no significant difference in the monthly calling frequency of birds along the Tafelkop path (ANOVA, $F_{8,69} = 1.00$, n.s.). There were no significant between-month differences in calling frequency after pooling data from both sites (ANOVA, $F_{8,143} = 1.21$, n.s.). The mean monthly calling frequency for the coastal tussock and fernbush habitat and for both habitats combined is present in Table 4.7.1.

Table 4.7.1: Monthly calling frequency [mean ∂ s.d. calls/minute (n of sites)] of territorial calls of Gough moorhens in coastal tussock and fernbush habitats, and both habitats.

Month	Coastal tussock	Fernbush	Both habitats
January	4.5 ∂ 2.5 (9)	9.5 ∂ 5.8 (10)	7.1 ∂ 5.1 (19)
February	5.7 ∂ 3.1 (9)	7.9 ∂ 4.9 (10)	6.9 ∂ 4.2 (19)
March	6.8 ∂ 4.5 (9)	7.7 ∂ 5.1 (10)	7.3 ∂ 4.7 (19)
April	4.3 ∂ 0.9 (4)	9.1 ∂ 5.2 (3)	6.4 ∂ 4.0 (7)
May	5.0 ∂ 3.3 (9)	9.5 ∂ 5.2 (10)	7.4 ∂ 4.9 (19)
June	8.2 ∂ 4.4 (9)	6.7 ∂ 2.8 (8)	7.5 ∂ 3.7 (17)
July	4.9 ∂ 3.1 (9)	9.4 ∂ 4.6 (9)	7.2 ∂ 4.4 (18)
August	8.9 ∂ 4.0 (9)	7.3 ∂ 3.9 (9)	8.1 ∂ 3.9 (18)
September	2.7 ∂ 2.1 (7)	5.0 ∂ 2.7 (9)	4.0 ∂ 2.7 (16)

Discussion

The difficulties inherent in surveying a cryptic gallinule species that is restricted to the thickly vegetated habitats of Gough Island are obvious, and the method chosen here is one that should be easily repeatable by observers. The variability of the counts means that this method is only likely to detect major changes in the abundance of Gough moorhens. The methods used in this study do not allow us to undertake an independent estimate of the population size of Gough moorhens. However, the results of this study suggest that Gough moorhens are more abundant in the fernbush than coastal tussock habitats, with a calling frequency 33.1% higher in fernbush areas. Watkins & Furness (1986) undertook their study in lowland fernbush habitat around the Meteorological Base and made the assumption that birds were at similar densities across the island. Moreover, Watkins & Furness (1986) estimated that there were 10–12 km^2 of suitable habitat on Gough. Habitat mapping during this study indicated that there is 4.6 km^2 of coastal tussock and 10.4 km^2 of fernbush habitat, indicating a total of 15 km^2 of suitable habitat. If the density estimate of Watkins & Furness (1986) is accurate (230 pairs km^{-2}), then with 15 km^2 of habitat there may be around 3,500 territorial pairs. If the differences in calling frequency between the two habitats reflect real differences in abundance, then there may be a total population of around 4,250 pairs. These revised estimates compare with the 2,000–3,000 pairs estimated by Watkins & Furness (1986). The accuracy of any population estimate is obviously dependent on the estimated density of pairs, and difficulties with mapping territories means that these densities should be treated with caution. Gough moorhens were easily caught in wooden box traps set around the base and baited with petrel carcass (RJ Cuthbert personal observations). A grid of traps and mark-recapture program could easily and fairly quickly provide a more robust measure of the density of birds.

4.8 Gough bunting *Rowettia goughensis*

Monitoring Gough buntings was complicated by the general low abundance of the species and variation in abundance in different habitats. Most breeding birds are found in upland areas of the island's plateau above 350 m asl, with lower densities of birds present around the coastal cliffs of the island. Breeding birds appear to be very scarce in fernbush habitat. Because of this, most research and monitoring methods were concentrated in Gonydale in the upland wet heath habitat of Gough Island, with some additional observations made along coastal areas. We attempted to census Gough buntings using standardised counts along transects with distance sampling. However, birds were so infrequently encountered in lowland habitats as to make the methods redundant, and in upland areas birds were consistently sighted in the same areas suggesting that we were re-sighting the same territorial individuals. Consequently, mapping of nests and territories was chosen as the best means to monitor Gough buntings. This was undertaken in Gonydale and the coastal cliffs from Tumbledown to the Admirals (Figure 2.1).

We searched approximately one third to a half of Gonydale (an area of approximately 0.7 – 1.1 km^2) for nesting localities of Gough buntings. This work was undertaken during late November and December 2000, and took around 2–3 full days of fieldwork per week during this time. Pairs could fairly easily be located by the territorial call (a downward slurring 'tsseeeeup') of male buntings, and males were then observed and followed as they brought food to the female on the nest. We made sure that we thoroughly searched all of the selected area of Gonydale for nests and are confident that all territorial pairs were located. This area was located at the northern end of Gonydale, enclosed by Green Hill, South Rowett and South Peak. All nests were marked and were later mapped using a hand-held GPS. We also searched for nests and territories of buntings from Tumbledown to the Admirals. In some instances nests could not be found because they were located on steep cliffs that were impossible to view. We did not map individual nests of buntings along coastal cliffs, but instead recorded the number of territories and total length of coastline searched.

Plate 4.8: Gough bunting (*photo: PG Ryan*).

Results

The average nearest-neighbour distance of bunting nests in Gonydale was 118 m (S E = 47m, *n* = 13–nests, 95% CI = 890-1460 m). Assuming that pairs occupy a circular territory then pairs nested at an average density 23.0/km^2 (S E = 9.3, 95% CI = 14.9 – 40.2 pairs/ km^2) in Gonydale. A total of five bunting territories were found along 2.9 km of coastline, giving an estimated density of 1.7 territories km^{-1}. If these densities are representative of other upland and coastal areas, then the results can be used to estimate the current population size of Gough buntings. With an area of upland wet heath habitat of 15.24 km^2 the upland population is estimated to be 350 pairs (range 227–612), and the 42.1 km of coastline may contain around 58–73 pairs. While some birds do nest in fernbush habitat, territories of birds were rarely observed in these areas (only one territory found despite considerable time spent in this habitat monitoring other species). Similarly, while birds were seen in all upland areas of Gough Island, the observed nesting locations (underneath a tree-fern or large tussock on a sheltered bank) and feeding behaviour of the species (foraging in vegetation for seeds and insects) suggests that nests were unlikely to occur in other upland areas comprising peat bogs, feldmark and bare rock. Consequently the total population of Gough buntings is estimated to be around 400–500 pairs.

Discussion

The methods used to monitor the abundance of Gough buntings are regrettably crude, but the scarcity and territorial behaviour of this species made other census techniques unfeasible. The method should still be capable of detecting a large-scale change in abundance of buntings. Finding nests was time-consuming and because breeding is not synchronous, searching for nests and territories must be carried out over several weeks in November and December. If large-scale aerial photos or maps of Gough Island were to become available, then bunting territories could fairly easily be mapped, based on locations of calling males and standardised mapping techniques. Such a method would be quicker, and should provide similar results to finding and mapping nests. A comparison of both methods should be undertaken before abandoning the methods used in this study.

Previous crude population estimates have varied between 200 (Richardson 1984) and 2,000 pairs (Holdgate 1957). The differences in abundance between different habitats may explain the variability of these estimates, as Richardson (1984) only briefly visited Gough Island and spent most of his time in coastal areas around The Glen where buntings are scarce, whereas Holdgate certainly visited upland areas of the island. The current estimated population of 400–500 pairs is less than the 1,000 pairs estimated in 1990 by Cooper & Ryan (1994). It is difficult to assess whether these different estimates represent a real decrease in numbers or just differences in methodology, although it should be noted that the earlier estimate is based on a very short period of sampling. Given the evidence for the role of introduced mice in predating bunting nests (Cuthbert & Hilton in press), further monitoring of Gough buntings is required.

Sunset from Gough Island (*photo: RW White*)

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Appendix 1: Instructions for weather station volunteers – seabird monitoring at Gough Island

Introduction

Gough Island is arguably the most important seabird island in the world, with 20 seabird species breeding on the island and tens of millions of pairs in total. It holds virtually the entire world population of the threatened Tristan albatross, as well as the world's largest population of sooty albatrosses, the second largest population of Atlantic yellow-nosed albatrosses, and over 100,000 pairs of rockhopper penguin and millions of burrowing petrels. Two of these species, the Tristan albatross and Atlantic yellow-nosed albatross, have been studied on Gough Island for over 20 years. This work has been undertaken by volunteers from the base (ie you!), and has provided invaluable data on the breeding biology of these species and the status of the populations. This information is vital for the conservation of these two species and for assessing trends in the population. The continuation of these long-term projects is a high priority, and requires commitment from future teams based at Gough Island and each team's effort will be of lasting importance.

Tristan (wandering) albatross

Tristan albatrosses or 'Gonies' lay eggs during January and rear chicks through until November to December. Because breeding takes almost a year, adults then spend a year at sea to moult their feathers and build up energy reserves for the next breeding attempt.

Tafelkop colony

During the takeover period the birder from the previous team should show you the path and layout of the Tafelkop study colony. This is also a good time to band the chicks on the Tafelkop colony and show the next birder how this is done. Revisit the Tafelkop colony in mid-January and spend a good day searching for nests and birds (usually 10 to 20 nests in a year). Mark and number all nests and record the identity of all birds that are incubating eggs. Ring any unbanded breeding bird on the RIGHT leg (using the J-series bands). Two people are needed to handle and band an adult or chick. Check all empty nests for the presence of even small fragments of eggshell and record this. Revisit the Tafelkop colony every couple of weeks (if the weather allows) until the identity of both birds of each pair is known. Also scan the area for any new and late nests. If possible record the identity of any banded loafing birds, without causing any undue disturbance.

Continue to visit the colony at monthly intervals to record the fate of nests (egg, chick or empty) and record if any chicks are found dead. In September band the now large chicks and show the next team's birder the procedure.

Gonydale and Albatross Plain

Because of the small size of the Tafelkop colony it is important to monitor a larger area of the island to get a better idea of the numbers of birds breeding and breeding success. Scan counts should be made of Gonydale and Albatross Plain to count the number of incubating birds (in late January) and number of surviving chicks (in September). Borrow the binoculars from the comms office and scan the areas from both sides making sketch maps as you go. Gonydale can be well counted from South Peak, Green Hill and from either West or South Rowett. Gonydale should be counted from at least two of these peaks to make sure that no birds are missed. The Gonydale area extends to the hummocky ground on the true right of the main stream, but does not include birds in the hummocks. On the true left of the main stream the count area extends along the slopes until the area becomes bluffed and the tussock habitat runs out. Albatross Plain should be counted from West Rowett and along the Rowett's from South Rowett to North Rowett. Again, make lots of sketches to ensure you count all birds.

During the late January count, try to only count birds on eggs and ignore loafing or courting birds (these often hang around in small groups and will be displaying to each other, as opposed to sitting on a nest). During September just count the number of chicks, taking care to not count adults. Take along the sketch maps from January so that you can link the number of chicks to eggs in different areas of Gonydale and Albatross Plain, and to ensure you recount the same areas. If possible band all the chicks in Gonydale on the LEFT leg. This should be done during September, possibly during the Takeover period with the conservation officer (who may well be a birdy type). This will be a full day’s work, as there are normally around 50–70 chicks. Additionally, over the year record the band number of any adult birds that are banded (there are quite a lot in Gonydale) and the leg that it is banded on.

Atlantic yellow-nosed albatross

During the takeover period the birder from the previous team should show you the location and layout of the study colony. They will explain the procedure to be followed (listed here) and give you study colony maps, notebooks, bird bands, plastic bands, ringing pliers and bamboo nest marker poles. Egg laying usually commences in early to mid-September and continues until mid-October. Visit the colony once a week, checking all nests for eggs that are laid. Record the nest number and the identity of the incubating bird from the yellow plastic band, and continue checking each nest until the identity of both birds is known. For breeding birds that are unbanded capture and attach a metal band (next number from the 8-series bands) to the RIGHT leg and a yellow-plastic band to the left leg. For breeding birds that are already banded on one leg, band on the other leg with a yellow-plastic band and record the metal band number. Enter new bands on to the yellow-nosed albatross spread-sheet.

Two people are needed to handle a bird and fit a band. Remove the bird from the nest and cover the egg (with a hat or anything handy to prevent skuas from taking it). One person should hold the bird (beak in one hand and its body with wings folded-in under your arm, and then grip the leg to be banded with your other hand), while the other attaches the bands. Make sure the metal band is not squeezed too tight and turns around the leg. Keep the yellow plastic bands warm (in an inside pocket), as they are brittle when cold, and stretch them a couple of times before putting it on the bird. Release the bird in sight of its egg and nest, which it should return to. If the bird runs away from the nest try to head it off and ‘shepherd’ it back to the nest. Occasionally a bird may break its egg when it climbs back on the nest: record it if this happens. Also record any bands that are broken or discarded.

Mark all new nests (with a blue plastic pole or bamboo pole) and give it a new number (next in series), and mark the approximate position of the nest on the colony map. On visits look for and record the presence of eggshells (even small fragments) in unoccupied nests. Where possible record the plastic band number of birds at nests without eggs, avoiding any undue disturbance. After egg laying is complete, continue to visit the study colony at approximately two week intervals and record the contents of the nest as ‘egg’, ‘chick’ or ‘empty’. Check empty nests carefully for signs of eggshell or chick down. In March band all chicks on the LEFT leg with a metal band (no plastic bands on chicks), using the next bands in the series and the banding pliers. Continue to visit the colony approximately every two weeks until all the chicks have fledged. Record the band and nest number of any chicks that died.

A small area adjacent to the study colony has been set aside as a control area for the study colony. This area is found between the two streams (that are crossed on the way to Tumbledown) up to the boundary with the Phylica trees. The previous year's birder should show you this area during takeover. This area should only be counted on three occasions over the year, and otherwise be left undisturbed. Most importantly this area should be counted in mid-October to record the number of nests occupied with an incubating bird. Preferably re-visit this area in early January and mid-March to count the number of small newly hatched chicks and large near fledging age chicks.

Summary of Atlantic yellow-nosed albatross protocol

- Weekly visits to study colony from mid-September to mid-October to record identity of both birds from pairs incubating eggs.
- For breeding birds, metal-band all un-banded adults on the RIGHT leg and add plastic bands to these birds and any bird that just has a metal band.
- After egg-laying is completed and both birds from each pair are known, visit the colony at two week intervals and record the nest contents (egg, chick or empty) of all nests.
- During March band all chicks on the LEFT leg with a metal band, and record the nest number.
- Continue checking at two-week intervals until all chicks have fledged, and record identity (band and nest number) of any dead chicks.
- Count the area between the streams, once during mid-October (incubating birds), once during early January (newly hatched chicks) and once during mid-March (nearly fully grown chicks).

Results

Enter all the data into the two bird monitoring Excel spread-sheets that should be on one of the computers in the comms room, and additionally enter the data onto the paper sheets (that are in the same format). Try to keep up to date at entering the data, as it is easier to spot mistakes when the information is fresh. Regularly e-mail the whole spreadsheet to John Cooper, Peter Ryan and Richard Cuthbert at:

jcooper@botzoo.uct.ac.za

pryan@botzoo.uct.ac.za

richard_cuthbert@yahoo.co.uk

They will periodically be e-mailing you to see how the work is going.

Appendix 2: Suggested fieldwork equipment

1. Large/medium size tramping pack and plastic pack liners
2. Footwear: some fieldworkers have suggested using gumboots, because the terrain is usually so wet that leather walking boots rapidly become waterlogged. However, gumboots are often less comfortable when walking long distances, give somewhat less grip, and can get lost in bogs. These drawbacks can potentially become real health and safety problems. The best solution is probably to acquire good leather walking boots with Berghaus 'yeti' gaiters, which give a Goretex covering to the entire boot.
3. Wool socks x 4
4. Walking poles
5. Waterproofs: a good quality breathable waterproof jacket and over-trousers are essential. Caution needs to be exercised with over-trousers. They give very little friction with short vegetation, and a fall on steep, wet terrain can lead to a tobogganing slide. A solution is to wear windproof and showerproof trousers (such as 'Mountain Equipment' aquafleece or ultrafleece) whenever weather conditions permit, and when working near the top of steep vegetated slopes.
6. Cheap plastic/rubber waterproof jacket and over-trousers (for digging burrows/wrestling penguins and seals)
7. Thermal tops and trousers x 2
8. Fleece jacket
9. Fleece or wool gloves, overmitts, warm hats
10. Leather fieldwork gloves (for handling penguins etc)
11. Sunscreen and sun-hat
12. Head torch
13. Three/four season sleeping bag (down is light but MUST stay dry)
14. Goretex bivvy bag or plastic bivvy bag
15. Thermal sleeping pad
16. Four season mountaineering tent that can withstand very strong winds. Take spare tent equipment, especially spare poles.
17. Large and lightweight angle tent pegs (ground is often wet and boggy)
18. Camping stove, of a design, and with a fuel that is safe to use inside tents
19. Watch
20. Large-scale map of Gough, and compass
21. Handheld GPS with spare batteries
22. Communications equipment (short-wave radio, satellite phone) as determined prior to fieldwork, with spare batteries
23. Waterproof binoculars
24. Waterproof and dry notebooks
25. Zip-lock plastic bags and pack liner bags
26. Wetsuit and booties
27. Spare supplies of high energy food
28. Standard camping and trekking equipment (eg water bottles, lighters etc)
29. Medical kit, suited to the skills and training of the fieldworker

NB all kit taken to Gough Island should preferably be new; if not it must be scrupulously clean, and must not harbour seeds or insects.

Appendix 3: Photo-points, maps and raw count data

1 Rockhopper penguin

Table A3.2.1: Location and description of rockhopper penguin plots.

	Location	
1a	Seal Beach	Area along coast to the south of the ropes down to Seal Beach and on south side of stream. This area is the first major area visible (see figure A3.1(a))
1b	Seal Beach	Area along coast to the south of the ropes down to Seal Beach and on south side of stream. This area is the first major area visible (see figure A3.1 (a))
1c	Seal Beach	Area along coast to the north of the ropes down to Seal Beach. The count area goes as far around this section of coast as possible towards the base until steep cliffs into the water demarcate the end of the breeding area
2a	Tumbledown	The initial bay and beach viewed from the ropes at Tumbledown, counting down to the point to the West of the ropes.
2b	Tumbledown	The long rocky beach running from the point West of Tumbledown ropes southwards until bluffs and cliffs prevent you counting further (ie around the corner from 2a)
3	Admirals	Go down the ladders and ropes at Admirals and walk around coast to the north for c 200 m. From here an enclosed lagoon is visible with obvious breeding penguins. The area next to the cliffs within the lagoon is counted.
4	The Glen	The colonies are located approximately 150 m inland from the beach at The Glen and are on the north side of the stream. These area are quite overgrown with vegetation and need to be counted with care.
5	Sophora Glen	Penguin colonies start within 25 m of the beach and extend up Sophora Glen for 300 m. Colonies are found on both sides of the stream and the thick vegetation means they must be counted slowly and with care.
6	Cavern Head	This area is to the south of Cavern Head with the areas being scan counted from the cliffs on the south side of Cavern Head (see figure A3.1(b))

Figure A3.1.1: Rockhopper penguin plots at Seal Beach, area 1a is marked with the red dashed line and extends out of sight to the right up until the stream becomes bluffed. Area 1b is marked with the blue dashed line.

Figure A3.1.2: Rockhopper penguin Area 6, scan counted from the South side of Cavern Head.

2 Tristan albatross

Figure A3.2.1: The distribution of incubating Tristan albatrosses during January 2001 and the boundaries of the different census areas. Figures are numbers of incubating pairs counted.

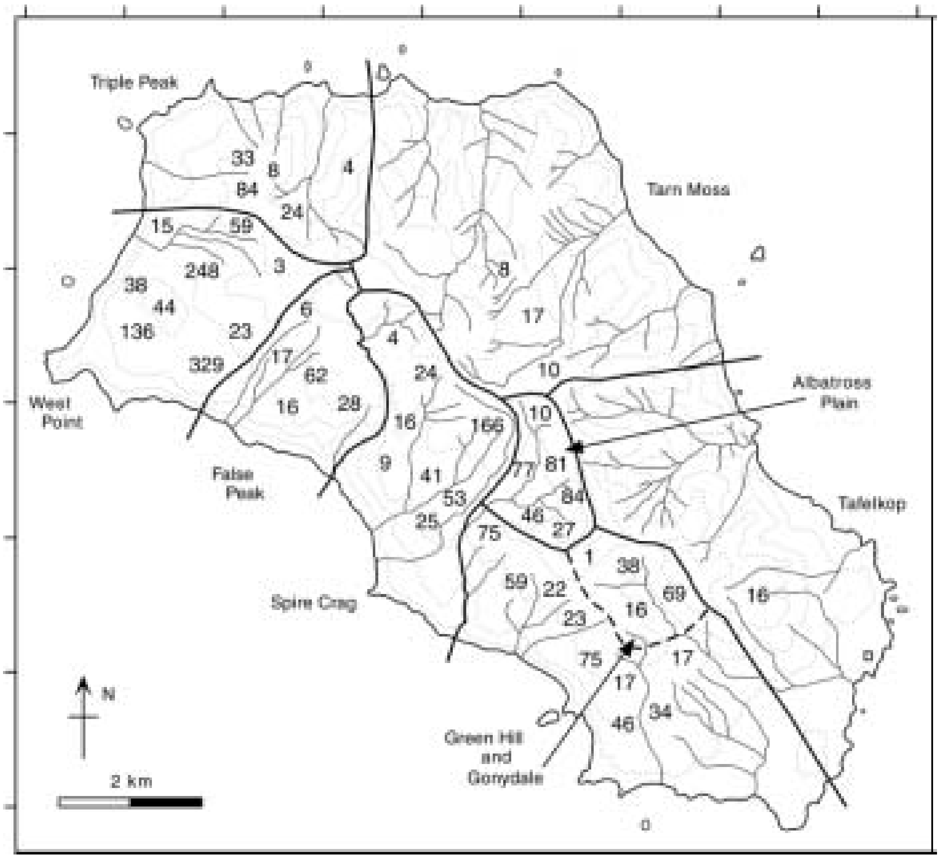


Figure A3.2.2: The distribution of Tristan albatross chicks during September 2000 and the boundaries of the different census. Figures are numbers of chicks counted.

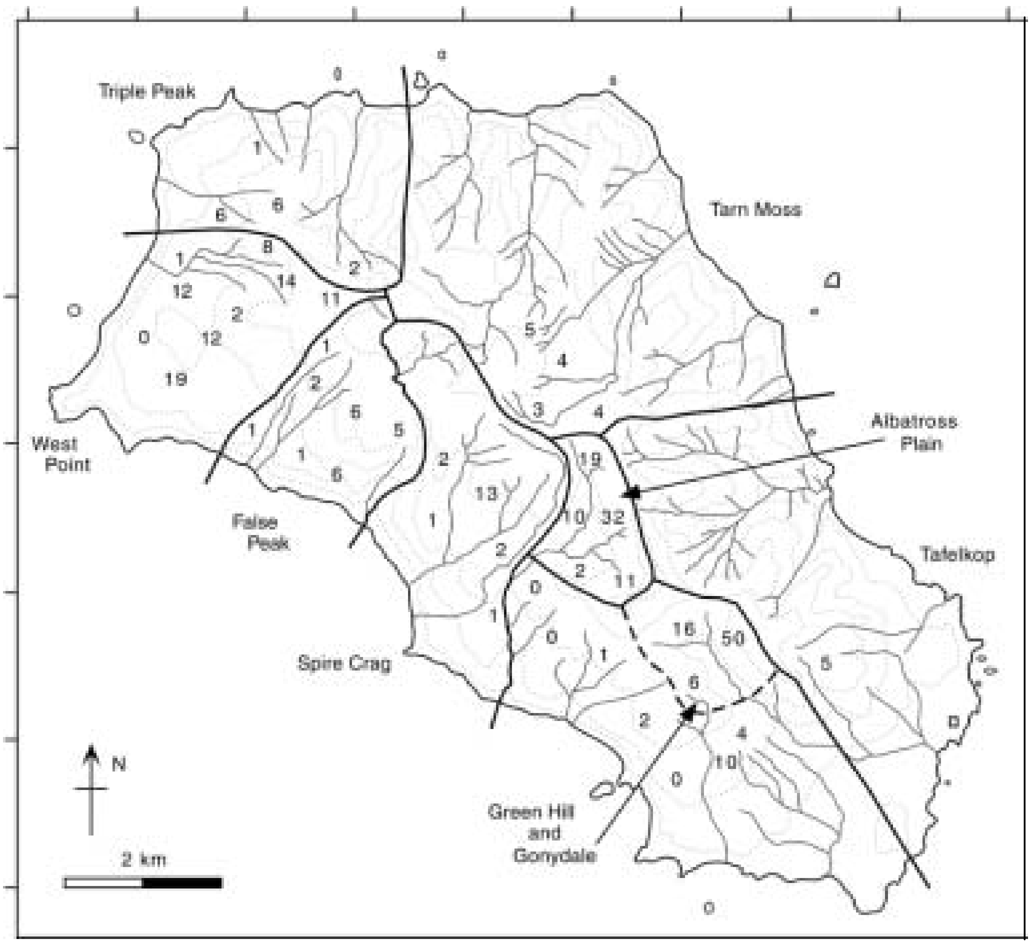
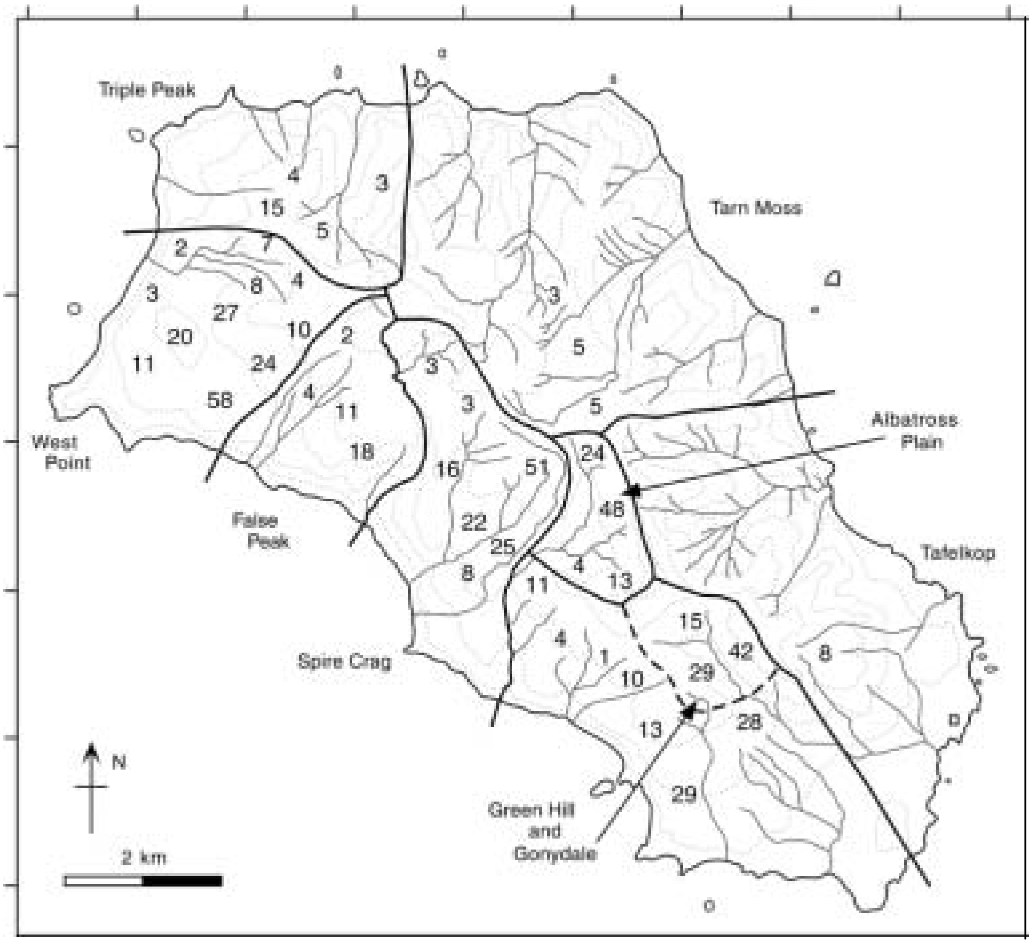


Figure A3.2.3: The distribution of Tristan albatross chicks during September 2001 and the boundaries of the different census. Figures are numbers of chicks counted.



3 Atlantic petrel

Table A3.3.1: GPS locations of start and finish of Atlantic petrel transects and location of other sites mentioned in text.

Description	Latitude 40∀S	Longitude 9∀W	Altitude m
Atlantic petrel Transect 1 start	20.89	52.963	
Atlantic petrel Transect 2 start	20.771	53.052	92
Atlantic petrel Transect 2 end	20.822	53.05	79
Atlantic petrel Transect 3 start	21.118	53.139	53
Atlantic petrel Transect 3 end	21.165	53.187	
Tumbledown ropes	21.438	53.053	49
Ropes above seal beach	21.159	53.011	
Blechnum Bridge	20.854	52.997	61
Centre of helipad	20.884	52.894	64
Pole in front of base with windspeed measure	20.97	52.833	55
Crane	20.012	52.797	49
Golden highway bottom	20.559	53.239	199
Golden highway top	20.527	53.276	211

Table A3.3.2: Atlantic petrel permanent quadrats with number of burrows, response to tape, and occupancy or active status, based on sign at the burrow entrance (see text for details of methods). Data for soft-plumaged petrel are included.

				Soft-plumaged petrel		***Atlantic petrel***		
Date surveyed	**Area**	**quadrat #**	**Small burrows**	**Total burrows**	**'Active'**	**Total burrows**	**'Occupied'**	**Response to tape**
18/07/2001	1	1	0	13	?	15	11	10
27/07/2001	1	2	0	8	5	7	3	2
18/07/2001	1	3	1	2	?	8	5	3
27/07/2001	1	4	0	1	?	2	1	1
18/07/2001	1	5	0	7	?	13	6	4
27/07/2001	1	6	0	14	6	10	5	3
18/07/2001	1	7	1	22	?	11	6	2
27/07/2001	1	8	0	11	5	15	9	5
20/07/2001	1	9	1	10	?	21	14	6
27/07/2001	1	10	0	17	9	9	6	5
20/07/2001	1	11	0	18	?	14	7	5
27/07/2001	1	12	0	0	0	4	3	1
20/07/2001	1	13	1	10	?	18	10	9

				Soft-plumaged petrel		*Atlantic petrel*		
Date surveyed	**Area**	**quadrat #**	**Small burrows**	**Total burrows**	**'Active'**	**Date surveyed**	**Area**	**quadrat #**
20/07/2001	1	14	3	20	?	12	8	3
01/08/2001	2	15	0	7	1	16	10	5
01/08/2001	2	16	0	15	9	25	12	6
01/08/2001	2	17	1	10	6	12	11	4
02/08/2001	2	18	0	5	1	17	8	2
30/07/2001	2	19	0	2	2	5	4	0
30/07/2001	2	20	1	4	3	14	8	7
30/07/2001	2	21	0	10	6	10	7	1
02/08/2001	2	22	1	17	8	15	4	4
30/07/2001	2	23	0	9	4	20	17	7
02/08/2001	2	24	0	10	6	20	8	9
30/07/2001	2	25	2	6	5	14	10	2
02/08/2001	2	26	1	5	1	17	9	3
27/07/2001	2	27	1	14	3	19	9	6
02/08/2001	2	28	0	12	7	19	12	4
27/07/2001	2	29	1	6	0	23	15	9
02/08/2001	3	30	2	5	2	15	8	4
02/08/2001	3	31	0	8	0	27	13	12
02/08/2001	3	32	1	10	3	19	9	8
05/08/2001	3	33	0	7	6	29	3	12
05/08/2001	3	34	0	9	6	21	1	3
05/08/2001	3	35	0	14	15	19	2	6
05/08/2001	3	36	0	10	6	19	0	6
05/08/2001	3	37	0	14	9	20	2	8
06/08/2001	3	38	0	10	3	9	0	3
06/08/2001	3	39	0	13	5	13	0	6
06/08/2001	3	40	0	13	5	20	3	8
06/08/2001	3	41	0	11	5	18	0	7
06/08/2001	3	42	0	7	3	11	0	0
06/08/2001	3	43	0	7	4	18	0	0