MARINE ORNITHOLOGY

Vol. 28 No. 2 2000

THE STATUS OF SPECTACLED PETRELS *PROCELLARIA CONSPICILLATA* AND OTHER SEABIRDS AT INACCESSIBLE ISLAND

PETER G. RYAN[1] & COLEEN L. MOLONEY[1,2]

[1]*Percy FitzPatrick Institute, University of Cape Town, Rondebosch 7701, South Africa (pryan@botzoo.uct.ac.za)*
[2]*Current address: Marine and Coastal Management, Pvt Bag X2, Roggebaai 8012, South Africa*

Received 22 March 2000, accepted 5 June 2000

SUMMARY

RYAN, P.G. & MOLONEY, C.L. 2000. The status of Spectacled Petrels *Procellaria conspicillata* and other seabirds at Inaccessible Island. *Marine Ornithology* 28: 93–100.

As a result of incidental mortality on longlines off eastern South America since the late 1980s, there has been concern about the population status of Spectacled Petrels *Procellaria conspicillata*. During December 1999 we counted Spectacled Petrels at their sole breeding locality, Inaccessible Island, central South Atlantic Ocean. Nesting is restricted to the island plateau, where we counted a minimum of 5900 burrows (estimated accuracy 5000–8000). Validation surveys at eight sites found that we underestimated burrow numbers (average 85±4% of actual number). Of 264 burrows checked, 55–67% of burrows were occupied during the early chick period, which extrapolates to 3800–4600 nests. Estimates of the breeding population are confounded by non-breeding birds occupying burrows and by breeding failures prior to the census, but the population of Spectacled Petrels is considerably greater than the estimate of 1000 occupied burrows made in 1982/83. It is unclear whether the population has increased or whether the 1982/83 count underestimated the population. However, we now have a baseline from which future changes in population status can be monitored. During the Spectacled Petrel survey we also checked breeding Atlantic Yellow-nosed Mollymawks *Thalassarche chlororhynchos* for bands, controlling 42 birds banded during 1982/83 at 510 nests checked. The breeding population of Subantarctic Skuas *Catharacta antarctica* was approximately 100 pairs, a five-fold increase on that recorded in 1982/83. A complete coastal survey in November 1999 revealed nine Rockhopper Penguin *Eudyptes chrysocome* colonies, with an extrapolated population of approximately 30 000 pairs. Casual observations on other seabirds are summarised, based on more extensive coverage of the island. Populations of Sooty Albatrosses *Phoebetria fusca*, Great Shearwaters *Puffinus gravis* and White-bellied Storm Petrels *Fregetta grallaria* probably are larger than the estimates reported previously.

INTRODUCTION

Inaccessible Island (37°18'S, 12°41'W), one of three main islands in the Tristan da Cunha archipelago, South Atlantic Ocean, is uninhabited and is currently free of introduced land mammals. In 1997, the island and surrounding territorial waters (to 12 nautical miles from the island) were proclaimed a Nature Reserve in terms of the Tristan da Cunha Conservation Ordinance (1976, as amended 1997). In addition to supporting endemic land birds, invertebrates and plants, Inaccessible is the sole breeding site for the Spectacled Petrel *Procellaria conspicillata* and supports globally-important populations of several other seabird species. Until recently Inaccessible was the least-known of the Tristan Islands, but the Denstone Expedition in 1982/83 and subsequent visits from 1987–1990 have greatly improved our understanding of the island's fauna and flora. The seabird fauna is reviewed in Fraser *et al.* (1988) with updates in Ryan *et al.* (1990). In this paper we provide further information on the seabirds of Inaccessible Island, gathered during a three-month visit to the island in summer 1999/2000.

One of our main aims was to re-assess the status of Spectacled Petrels, or Ringeyes as they are known locally. This species, recently recognised as a valid species distinct from the closely-related White-chinned Petrel *P. aequinoctialis*, is known to suffer considerable mortality on longlines off southern Brazil (Ryan 1998, Olmos *et al.* 2000). Prior to our census, the most recent population estimate (and the only real attempt to count the breeding population) was made in 1982/83, when 563 'active' burrows were counted in approximately 1 km^2 on the island plateau (Fraser *et al.* 1988). This was estimated to represent roughly half the suitable habitat, giving a breeding population estimate of 1000 pairs (Fraser *et al.* 1988). With some 200 Spectacled Petrels being killed per year on longlines from the late 1980s, there was real concern for the survival of the species.

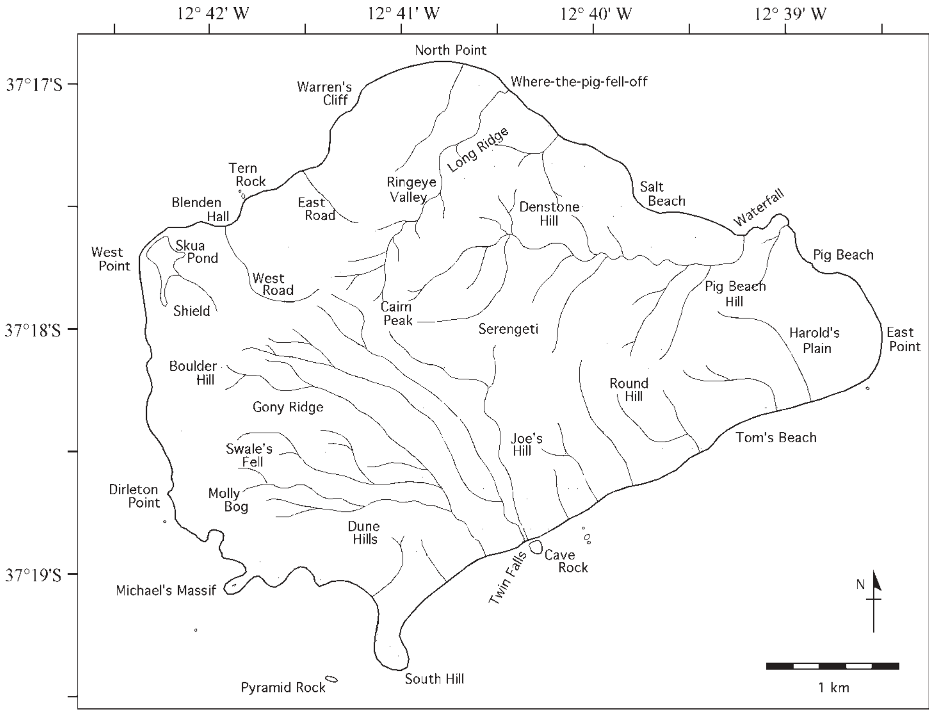

Fig. 1. *Inaccessible Island, showing localities mentioned in the text. Map redrawn from Siddall (1985) using satellite imagery and GPS fixes. Contour interval approximately 50 m.*

We also estimated the populations of Rockhopper Penguins *Eudyptes chrysocome* and Subantarctic Skuas *Catharacta antarctica*, and checked breeding Atlantic Yellow-nosed Mollymawks *Thalassarche chlororhynchos* for bands applied in 1982/83. Counts of Tristan Albatrosses are to be presented elsewhere (Ryan *et al.* 2001). Observations on other seabirds were made on an *ad hoc* basis, but benefited from the greater coverage of the island achieved relative to previous expeditions, including a camp on the island plateau.

METHODS

We visited Inaccessible Island from 4 November 1999 to 9 February 2000. From 4–14 November we camped at Waterfall Beach on the east coast of the island, and surveyed the coastal areas between the area north of Salt Beach, around East Point to below Joe's Hill on the south-east coast (Fig. 1). From 14 November onwards we camped at Blenden Hall, on the west coast, where there is straightforward access to the island plateau. From this base we surveyed the coast from North Point to Dirleton Point, and visited the entire plateau. Exploration of the plateau was enhanced by having a camp near the confluence of numerous streams making up Waterfall River near Denstone Hill (38°17.6'S, 12°40.4'W), where we spent 22 nights. On 23 November landings were made from *Wave Dancer 1*, a rigid inflatable boat (RIB), on the beach at South Hill and Where-the-pig-fell-off (both penguin colonies). The coast between Dirleton Point and Cave Rock also was surveyed from the RIB the same day, completing coverage of the island's coast.

Spectacled Petrel census

Systematic counts of Spectacled Petrel burrows were made from 5–15 December, towards the end of the incubation period. Burrows were counted within specific river catchments (e.g. Ringeye Valley), or, for the western plateau, from north-south transects that ran across the major drainage lines. For the latter transects a GPS was used to ensure good coverage of the area and to record the location of major concentrations of Spectacled Petrel burrows or 'colonies'. Transect lines were walked every 0.2 minutes of longitude (12°41.3'W, 12°41.5'W, 12°41.7'W), approximately 300 m apart. On each transect, the two observers walked 100–200 m apart, deviating to visit colonies. Burrows are concentrated along streams and in 'Ringeye bogs' (see Results), which stand out clearly from the surrounding bogfern *Blechnum palmiforme* heath.

At each colony a rough count of the number of burrows was made. This involved walking through each colony, and estimating the number of obvious burrow entrances, typically to the nearest five burrows. Initial attempts to count more accurately, and to record signs of recent activity (cf. Fraser *et al.* 1988) were abandoned as impractical. There were too many colonies to count individual burrows, especially as many burrows have multiple entrances and some burrows share the same entrance. Also, signs of recent activity, in addition to being time consuming to observe and record, were not feasible for many of the burrows with large entrance moats, especially where those from several nests formed a common pool. Instead a validation exercise was conducted from 28–30 December, after most eggs had hatched, to assess the accuracy of the count technique and to estimate the proportion of occupied burrows. This entailed selecting defined areas at eight Spectacled Petrel colonies spanning the range of habitats used. At each area, both observers independently estimated the number of burrows in the manner used in the overall census. Then a thorough, burrow-by-burrow check was made to count the actual number of nests and to assess their status.

Three criteria were used to check whether burrows were occupied. First, a 10-s playback of Spectacled Petrel calls was played directly down each burrow, and the response noted:

calling by adult(s), chick or no response. The playback tape was recorded away from the trial areas, and involved two birds in the same burrow; presumably a male and female. After playback, the burrow entrance was examined for signs of recent activity: fragments of egg shell, feathers, droppings, fresh digging or footprints. As already noted, this is not always possible if there is a large moat shared by several burrows. Finally, an arm was inserted down the burrow as far as could be reached (approximately 1 m), and the burrow scored as either occupied (adult and/or chick felt), empty, or uncertain (where nothing was felt but the burrow extended beyond the reach of the extended arm). A more intrusive approach, such as digging access holes to be able to reach of the end of all the burrow chambers, was deemed to be an unnecessary disturbance. In a small number of nests the 'arm probe' trial was not conducted because of the large size of the entrance moat. Occasionally birds called spontaneously during the inspection. Adding these to the known-occupied burrows (from feeling) allowed a second estimate of occupancy from playback responses.

Other seabird observations

Counts of Rockhopper Penguins in beach parties were made on foot at each colony between 5 and 23 November, with multiple counts at four colonies: Waterfall, Salt Beach, Blenden Hall and Warren's Cliff. Ryan *et al.* (1990) showed a strong correlation between beach party size and approximate colony size, and this was used to estimate the total breeding population. During the Spectacled Petrel census, most Yellow-nosed Mollymawks encountered were checked for bands. We attempted to limit our search to areas where banding took place in 1982/83 (M.W. Fraser *in litt.*), but the boundaries of the 1982/83 effort were not always clear. We also scored the proportion of birds on eggs, brooded chicks and chicks left alone, irrespective of position on the island. All Subantarctic Skua nests were plotted with the aid of a GPS to determine inter-nest distances.

RESULTS AND DISCUSSION

Spectacled Petrel

The structure of Spectacled Petrel burrows has been described by Rowan *et al.* (1951) and Hagen (1952). They are readily distinguished from the nests of all other burrowing petrels at Inaccessible Island by their large size. The presence of an entrance pool or moat is characteristic, but not diagnostic. Some burrows are under sparse tussock *Spartina arundinacea* grassland (e.g. above Molly Bog) or under procumbent *Phylica arborea* trees, but most are found in bogfern heath (cf. Roux *et al.* 1992). Within this community, nests are concentrated along streams and at Ringeye bogs, areas of *Scirpus* bog created and maintained by the burrowing and manuring activity of the petrels. These appear to form along streams, but move up-slope as successive generations of burrows collapse and the petrels dig new burrows in the adjacent bogfern. The old burrow moats coalesce to form a large pool, which is colonised by the forb *Callitriche christensenii* and sedge *Scirpus sulcatus*. Often successive waves of burrows form a series of terraces that resemble rice paddies.

All Spectacled Petrels bred on the plateau of Inaccessible Island, with most on the high, western plateau west of a line between Where-the-pig-fell-off and Dune Hills (Fig. 2). The only burrows found on the eastern plateau were on the upper slopes of Round Hill and Denstone Hill. The total area occupied by Spectacled Petrels was approximately 160 ha (1.6 km^2), but they were patchy within this range (Table 1). A total of 5900 burrows was counted (Table 1), and our intuitive feeling prior to the validation exercise was that the true number lay between 5000 and 8000 burrows. We believed the number counted was likely to be an underestimate because, firstly, coverage was not complete (we focused on Ringeye bogs and streams where nests were concentrated) and secondly, some burrows located under dense vegetation (*Spartina* and *Phylica*) were only found because birds were heard calling: other concealed nests probably were overlooked. The greatest concentrations were found in Ringeye Valley (approximately 1700 burrows) and on Gony Ridge (1100 burrows). Average density was 36 nests.ha^{-1} (range 9–109; Table 1), but this is misleading, because of the extreme clumping of nests. Within Ringeye bogs, nest densities were approximately 0.1–0.2 nests.m^{-2}.

TABLE 1

Counts of Spectacled Petrel burrows at Inaccessible Island (see Fig. 1 for areas)

	Count area	No. of burrows	Area (ha)
A	Dune Hills (seaward slopes)	180	6
B	Molly Bog River	375	10
C	Swales Fell	195	22
D	Gony Ridge	1125	40
E	Boulder Hill River to Twin Falls River West	225	21
F	Twin Falls River West to Twin Falls River East	610	20
G	Eastern drainage into Twin Falls River West	610	6
H	SE Cairn Peak, draining into Joe's River	437	4
I	Southern slopes Long Ridge	230	5
J	Ringeye Valley – top	380	6
K	Ringeye Valley – middle	568	10
L	Ringeye Valley – bottom	795	8
M	Denstone Hill	50	1
N	Round Hill	120	3
Total		**5900**	**162**

The eight validation areas contained 264 burrows, an average of 33 per area. The two observers estimated 83% and 85% of the true number, with the estimates within each area ranging from 59–102%. Combined count accuracy was 84.8±3.8% (SE). This suggests that the number of burrows is 6600–7500, although this fails to account for burrows not detected amongst dense vegetation. Under-counting was most marked in areas where burrows were loosely aggregated; estimates were close to the true number in areas where burrows were concentrated in Ringeye bogs. However, the implied accuracy is somewhat misleading as the superficial count technique is misled by 'false' burrows (typically old, collapsed burrows that form as the bogs erode up-slope), single burrows with multiple entrances, and burrows with the same entrance. In the validation exercise these made up 10%, 9% and 5% of burrows, respectively (but note that false burrows were excluded from the total number checked). Any future censuses must repeat

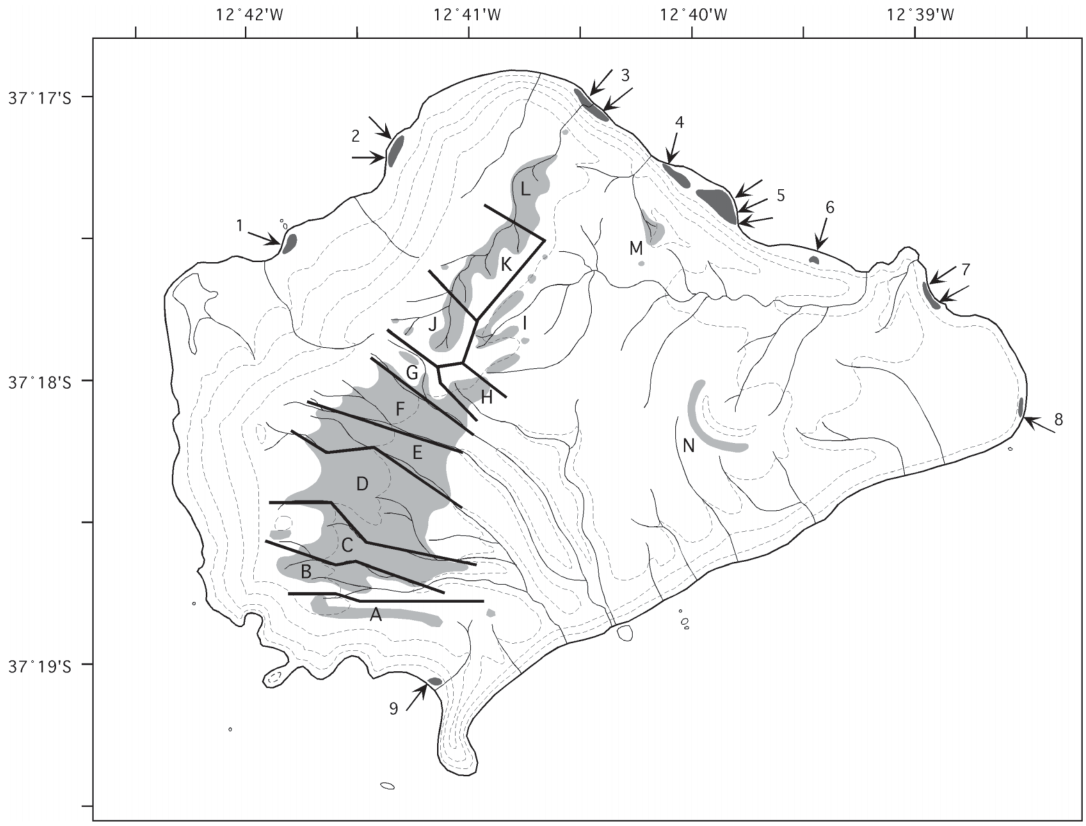

Fig. 2. *The distribution of Spectacled Petrel burrows (pale shading) and Rockhopper Penguin colonies (dark shading) at Inaccessible Island. Spectacled Petrel count areas are labelled A–N (Table 1), penguin colonies 1–9 (Table 3). Arrows show the main access routes to penguin colonies.*

the validation exercise to overcome these problems. All instances of multiple burrows with a common entrance involved two nests.

The results of the burrow occupancy tests are summarised in Table 2. All criteria were independent of whether or not birds responded to tape playback. For example, the proportion of nests where birds were felt by arm-probing was not significantly greater at burrows where birds responded to tape (16.7%) than where there was no response (9.8%, $\chi^2 = 1.78$, $P > 0.1$). Similarly, there was no relationship between response to tape playback and all signs of activity combined ($\chi^2 = 2.06$, $P > 0.1$). Of the 28 nests where birds were felt during the arm-probe, only 14 responses to tape playback were obtained. Extrapolating from the total number of responses obtained (88), suggests that 88/(14/28) = 176 nests (68%) were occupied (cf. James & Robertson 1985, Gibbons & Vaughan 1998). This is similar to the proportion of burrows that showed signs of recent activity (62%, Table 2). However, if the burrows where birds called independent of playback were included, the playback response rate (16/39) extrapolates to an occupancy of 81%. This calculation is sensitive to the ratio of responses received from known-occupied nests and unknown nests, giving occupancy estimates >100% if the response rate from unknown nests exceeds that of known nests. A more conservative approach using one or more of response to playback, bird felt (including dead birds) or egg shell fragments gave an occupancy estimate of 55%.

These results suggest that 3800–4600 burrows were occupied at the end of December. The relationship between this estimate and the breeding population is confounded by two factors. Breeding numbers are underestimated because some breeding attempts would have failed before the survey; at Marion Island 37% (range 28–45%, n = 4 years) of White-chinned Petrel nests fail before the eggs hatch (Percy FitzPatrick Institute unpubl. data). Conversely, breeding numbers are inflated by some burrows being occupied by non-breeding birds (and failed breeders), although this is likely to be limited (Berrow 2000). One way to avoid the latter problem is to only use data for chicks; two of the four felt responded to playback, suggesting a burrow occupancy by chicks of 41%. But this estimate is not robust due to the small sample size; changing the number of chicks responding by one bird alters the estimate to 21% or 82%!

Although the breeding population cannot be estimated accurately, it is considerably greater than the 1000 pairs (actually occupied burrows) estimated in 1982/83 (Fraser *et al.* 1988). It is uncertain whether the increase is a real one, or an artefact of different census techniques, but our subjective opinion is that the density of burrows has not changed since the late 1980s. The 1982 census was conducted at the same time as banding Yellow-nosed Mollymawks, and this probably detracted from the accuracy of the Spectacled Petrel count. The 1999/2000 population estimate alleviates immediate concerns about the survival of Spectacled Petrels, but incidental mortality on longlines remains a long-term threat to the species. The most recent estimates are that 750 (500–1000) Spectacled Petrels are killed on longlines each year off Brazil (Olmos *et al.* 2000), 5–10% of the estimated total species' population. In the absence of data on population trends, it is prudent to assume that longline mortality is causing the population to decrease. Strict application of the IUCN criteria

TABLE 2

Evidence for occupancy of Spectacled Petrel burrows. Sample size (n) varies because not all tests could be made at each nest; see text for further details

Criterion (n)		Number	%
Response to tape (n = 264)	Adult(s)	49	18.6
	Chick	54	20.5
	Either adults or chicks	88	33.3
Signs of activity (n = 229)	Egg-shell fragments	35	15.3
	Feathers	104	45.4
	Tracks	38	16.6
	Droppings	11	4.8
	Fresh digging	2	0.9
	At least some sign of occupancy	142	62.0
Arm probe (n = 237)	Bird(s) felt	28	11.8
	Dead chicks	4	1.7
	Dead adults	1	0.4
	Empty	11	4.6
	Uncertain (nothing felt, but burrow too long)	193	81.4

suggests that the Spectacled Petrel should be classified as Critical (a single population restricted to an area <10 km^2 and an inferred decline in numbers of mature individuals; criteria B1+2e, Collar 1999, BirdLife International 2000). However, it only qualifies as Vulnerable in terms of its very small range (D2) or small, declining population (C2b).

We now have a baseline from which to monitor future changes, and a count methodology that should be repeatable and comparable between censuses. Probably the most important modification would be to conduct the occupancy estimate during the incubation period (late October–mid-December) when the proportion of adults responding to tapes is likely to be uniformly high (Berrow 2000). The complete island survey took approximately 20 person-days to complete, but the total time commitment to repeat the survey would be at least two weeks. This is because of the need for clear weather on the plateau at least during the burrow count exercise. Clouds cover the plateau on roughly half of days in summer (Roux *et al.* 1992). Increasing the size of the count team would speed up the survey, but would also increase observer bias effects. A more time-efficient monitoring strategy would be to survey only a proportion of the population. Ringeye Valley, which runs north-east from the top of the West Road to Where-the-pig-fell-off (Fig. 2), is the best-defined area that contains a substantial proportion of the population (30% of burrows, Table 1). Two experienced observers could count the burrows in this valley in a single day, with another day needed for occupancy validation.

Rockhopper Penguin

Ryan *et al.* (1990) reported six definite and three suspected penguin colonies at Inaccessible Island. We were able to confirm that there are nine colonies, but those mapped in Ryan *et al.* (1990) around Salt Beach are incorrectly placed; the correct locations are plotted in Fig. 2. The absence of colonies from the south-east coast (between East Point and South Hill) probably is related to the near vertical cliffs that characterise that stretch of coast. The location of the colony virtually wiped out by pigs on the 'south coast' (Moseley 1892, Hagen 1952) remains unclear.

Counts of penguins in beach parties varied little during the November census period, and are consistent with those made on 28 November 1989 (Table 3). The lower counts in 1989 probably result from those counts being made from a ship offshore. The mid-November beach parties crudely represent 10–15% of the number of breeding pairs (Ryan *et al.* 1990), an assumption which is further supported by examining the extent of colonies from the cliffs above them. This suggests that the population at Inaccessible is approximately 30 000 pairs, with the largest concentration on the north-east coast between Salt Beach and Where-the-pig-fell-off, where three colonies support 60% of the island population.

TABLE 3

Counts of Rockhopper Penguins in beach parties at Inaccessible Island. Colony numbers refer to Fig. 2

Colony	1999 counts (range)	1989[1]
1. Blenden Hall	180 (140–200)	100
2. Warren's Cliff	380 (320–450)	500
3. Where-the-pig-fell-off	700	500
4. Salt Beach north	350 (320–400)	–
5. Salt Beach (main)	900 (800–1000)	950[2]
6. Waterfall slump	180 (150–220)	150
7. Pig Beach	300	100
8. East Point	220	80
9. South Hill	130	no count
Total	**3 340**	**2 380**

[1] from Ryan *et al.* (1990); counts made from a boat offshore.
[2] counts for Salt Beach 'north' and 'south' combined.

Atlantic Yellow-nosed Mollymawk

Atlantic Yellow-nosed Mollymawks breed primarily on the plateau of Inaccessible Island, although there are approximately 50 pairs on the Dragon's Teeth and adjacent 'slump steps' on the East Road, as well as 5–10 pairs in a small valley half-way down the coastal cliff between Joe's Hill and Round Hill. Although we did not attempt a comprehensive census of the breeding population, we gained the impression that the number of occupied nests was less than in the late 1980s. None was breeding on the West Road (previously 1–2 nests) or on our old route to Denstone Confluence (five nests). Also, the area in upper Ringeye Valley where we marked 50 nests to estimate breeding success in 1989/90 (Ryan *et al.* 1990) had only 41 nests on 9 December 1999. Some would have failed by this date (in 1989, four of 50 were abandoned by 10 December), but there were many more than the 50 nests marked in 1989. However, the impression that numbers have decreased could result from a particularly poor breeding season in 1999/2000. Breeding success in a long-term monitoring colony at Gough Island was unusually low in 1999/2000 (A. Lombard *in litt.* to J. Cooper), and there is a correlation between breeding success at Gough and Tristan (J. Cooper pers. comm.).

Breeding is well synchronised. The first chick was found on 25 November, and by 2 December at least 75% of eggs had hatched. The last eggs were seen on 15 December (three of 65 nests), but these might have been infertile. The first chick left alone after the brood phase was seen on 11 December, but they remained scarce until after 20 December (only four of 20 alone on 19 December). However, almost all chicks were left alone by the end of December.

During the Spectacled Petrel census we found 42 banded Atlantic Yellow-nosed Mollymawks among 510 breeding adults checked for bands. All but two were either incubating eggs or brooding chicks; the two exceptions were both occupying empty nests. None of more than 200 loafing birds checked was banded. All had been banded at Inaccessible Island during the Denstone Expedition in 1982/83, when 1120 adults and 573 chicks were banded (Fraser *et al.* 1988). Of the birds controlled in 1999, 31 were banded as adults and 10 as chicks (one ring number could not be read completely). Given that only one member of each pair was checked during the survey, it is likely that at least 84 banded birds survive from 1982/83, giving a minimum annual survival estimate of 0.838. As expected, chicks had a slightly lower average annual survival (0.821) than adults (0.843). These survival estimates are similar to values we estimated from retraps at Nightingale Island in 1999/2000. Together with Tristan Natural Resources Department personnel we counted all Atlantic Yellow-nosed Mollymawks breeding at The Ponds, Nightingale, on 21–22 October 1999. On First Pond we found one of 50 adults banded by John Cooper in November 1984 and on Second Pond we found five of 110 adults banded by Barry Stead in November 1985. Again assuming this represents only half of the surviving birds, the minimum annual survival is 0.81 and 0.85, respectively. No birds were found with bands from earlier than 1984 (see Morant 1977, Hagen 1982, Cooper & Fraser 1988).

Sooty Albatross

The population of Sooty Albatrosses at Inaccessible is hard to count accurately, because most breed on the sheer coastal cliffs and scarps. The population on the plateau is 80–100 pairs, with the largest single group (17 nests) on the north slope of Gony Ridge where it drops steeply into Boulder Hill River (37°18.3'S, 12°41.2'W). This site had only five nests in 1982/83 (Fraser *et al.* 1988). Other plateau sites include the southern slopes of Long Ridge, Denstone Crag and Round Hill. Fraser *et al.* (1988) estimated the total population as 200 pairs, considerably less than Elliott's (1957) 2000 pairs. The difference may well lie in the different areas visited by different observers; although Sooty Albatrosses breed along the coastal scarp above Blenden Hall (and are fairly common on the Dragon's Teeth to the east of the West Road), they are much more abundant along the remaining coastal cliffs, especially along the southern coast between Dirleton Point and East Point. We estimate the island population to be at least 500 pairs.

Burrowing petrels

Camping on the island plateau made evident the abundance of Great Shearwaters nesting under *Phylica* woodland on the eastern half of the island. They are especially abundant on the eastern hills (Denstone and Round Hills) where there is dense woodland with an understorey of ferns (typically *Ctenitis aquilina*). We estimated burrow density to be approximately 0.5 m^{-2} in this habitat, which has an area of *c.* 1.5 km^2. We were also able to confirm that the high density of this species (*c.* 1 m^{-2}) in tussock *Spartina arundinacea* and *Phylica* woodland along the edge of the plateau rim (Fraser *et al.* 1988) occurs all around the island (*c.* 1 km^2). Adding these populations to the estimated 0.2 burrows m^{-2} in the 4 km^2 of coastal scarp tussock (Fraser *et al.* 1988) gives an estimated breeding population of at least two million pairs, probably similar to that at Nightingale Island. Interestingly, there is anecdotal evidence that the population has increased since the 1950s. Lindsay Repetto and other Tristanians report that there were very few breeding in the tussock at Blenden Hall in the early 1950s, and state that the numbers in 2000 are the most they have seen. We gained the impression that numbers in the tussock around the hut at Blenden Hall had increased even since 1989/90.

Among the truly nocturnal petrels, three species predominated at all sites (Waterfall, Blenden Hall and Denstone Confluence): Broad-billed Prion *Pachyptila vittata*, White-bellied Storm Petrel *Fregetta grallaria* and Soft-plumaged Petrel *Pterodroma mollis*. Two species were less abundant at these sites: White-faced Storm Petrel *Pelagodroma marina* and Common Diving Petrel *Pelecanoides urinatrix*. Little Shearwaters *Puffinus assimilis* apparently are restricted to dense tussock, and were found at Waterfall and Blenden Hall. Kerguelen Petrels *Lugensa brevirostris* were only encountered at Denstone Hill, where they were scarce. Based on these observations, coupled with their predominance in skua middens and pellets even well before their breeding season commences, we suggest that the population of White-bellied Storm Petrels is similar to that of Broad-billed Prions (estimated as 50 000–500 000, Fraser *et al.* 1988). Soft-plumaged Petrels probably also have a larger population than the previous estimate of 5000–50 000 pairs. They were found occupying burrows from sea level to the highest point of the island (scarp edge near Swale's Fell) and in all habitats from tussock to *Phylica* woodland. We suggest a conservative estimate of 10 000–100 000 pairs. Common Diving Petrels also occur throughout the island, with a fledgling found at Denstone Confluence; we suggest the population is 5000–50 000 pairs.

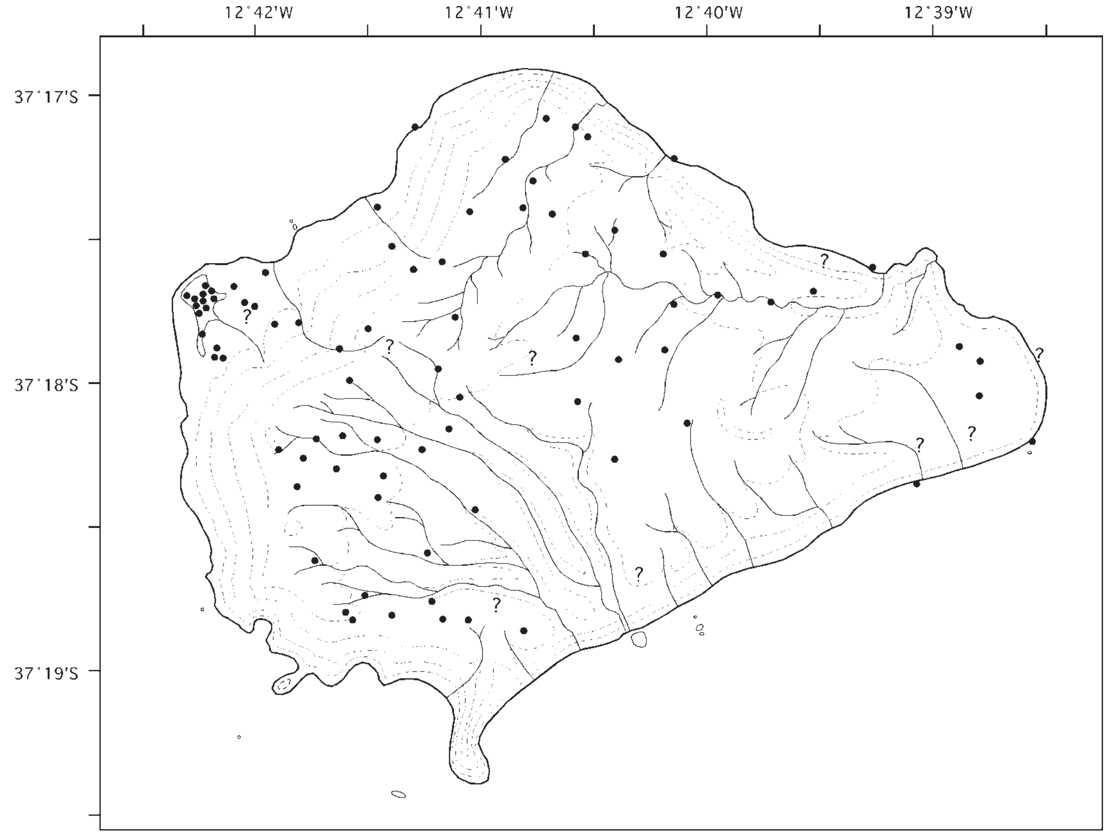

***Fig. 3.** The distribution of Subantarctic Skua nests at Inaccessible Island. ? denotes pairs holding a territory but where a nest was not found.*

Subantarctic Skuas

Fraser *et al.* (1988) reported only 17 pairs of Subantarctic Skuas breeding at Inaccessible Island in 1982/83, and argued that few nests were overlooked given the noisy and conspicuous nature of breeding pairs. We found 81 confirmed nests, with nine other pairs holding territories (Fig. 3). The actual number of breeding pairs is likely to be closer to 100 pairs. Some pairs may have been overlooked because areas were visited after their nests had failed or their chicks had fledged. The survey of most of the plateau took place in conjunction with the Spectacled Petrel census (mid-December), but some areas were only visited for the first time in late December. Breeding is protracted, but some birds already had large, feathered chicks in mid-November, and free-flying juveniles were seen from mid-December. Other pairs still had downy chicks in late January.

With the exception of the concentration at Skua Pond and adjacent areas around West Point, nests are distributed regularly across the island (Fig. 2). The density of nests is greater on the western plateau than on the eastern plateau; respective mean nearest-neighbour distances were 210 m (SD 71 m, n = 28) and 332 m (96 m, n = 15). Some of the increase relative to the 1982/83 count probably is due to greater coverage, but this cannot account for most of the increase in breeding numbers. The reason why the breeding population has increased over the last two decades is unclear; it is not related to a shortage of potential breeders in the past. Then, as now, 60–120 non-breeding skuas congregate in the 'club' at Skua Pond during summer (Ryan & Fraser 1988, Ryan & Moloney 1991). Smaller clubs form at other sites on the island, including the plateau, after the chicks fledge.

Terns and noddies

Fraser *et al.* (1988) reported breeding by Antarctic Terns *Sterna vittata* at four sites, with the greatest concentration (70 nests) on the cliff at Salt Beach. This latter site presumably is in error for the cliff above the old huts at the Waterfall. In November 1999 this cliff supported only 10–20 pairs of Antarctic Terns; whether this is a real decrease or the 1983 estimate was optimistic is unknown. Terns failed to breed at the trachyte shield behind West Point in 1999, having done so in 1982, and 1987–1989. They did breed at Dirleton Point and Warren's Cliff (including the first nest at the base of the cliff since 1982), and new nest sites were found at Pig Beach Point (one to two pairs), around East Cape (two to four pairs) and on the sheer south-western coast from Dirleton Point to South Hill (perhaps 20–30 pairs). We estimate the total population to be 50 pairs, somewhat less than the > 86 pairs reported by Fraser *et al.* (1988).

Common or Brown Noddies *Anous stolidus* also were reported to breed on the cliff at Salt Beach (Fraser *et al.* 1988); again this should be the cliff at the Waterfall. We estimated there were 10–20 pairs on this cliff (30 in 1983, Fraser *et al.* 1988), with two pairs nesting in the pine trees *Pinus caribea* beneath the cliff. Numbers nesting at Blenden Hall had increased from two to three pairs in the 1980s to at least six pairs in 1999, with all nests in the two apple *Malus domestica* groves. There was considerable spread in the timing of breeding: on 8 December the upper grove contained one bird on an empty nest, two incubating eggs, one brooding a small chick and one fully-feathered chick ready to fledge. By the end of January the copse contained three fledged chicks still being fed by their parents and a large downy chick. Three new breeding sites were one nest in a *Phylica* tree on the East Road, one on the cliff at Pig Beach Point and one in dense *Phylica* woodland on the eastern flank of Round Hill, more than one kilometre inland. There may also be more nests along the southern coastal cliffs. We estimate the total population to be 50–100 pairs, compared with the previous estimate of >33 pairs (Fraser *et al.* 1988).

CONCLUSIONS

This paper provides new information on the population status of 11 of the 16 seabird species confirmed to breed at Inaccessible Island. With the exception of Atlantic Yellow-nosed Mollymawks and Antarctic Terns, all population estimates are increases over those reported by Fraser *et al.* 1988. However, for most species the revised estimates result from better coverage of the island rather than a real change in population size. Two exceptions are Great Shearwaters and Subantarctic Skuas, which appear to have undergone marked increases over the last 20–50 years. Most of the island's seabird populations appear to be healthy. The two species that currently give cause for concern are the Spectacled Petrel and Atlantic Yellow-nosed Mollymawk, which are known to suffer significant longline fishing mortality. Repeated censuses, using standardised techniques, are required to confirm these trends.

ACKNOWLEDGEMENTS

This paper is dedicated to the people of Tristan da Cunha for their foresight in declaring Inaccessible Island a Nature Reserve. Our visit to Inaccessible during 1999/2000 was made possible through grants from the World Wide Fund for Nature (UK) and the National Geographic Society. Logistic support was received from the South African Department of Environmental Affairs and Tourism, and especially from the crews of *Wave Dancer 1* and *2* at Tristan. We are particularly grateful to James Glass of the Tristan Natural Resources Department for co-ordinating our visit. We also thank James and Norman Glass and Tanya Rogers for maintaining radio contact. Conrad Glass very kindly helped with the coastal survey of penguins from *Wave Dancer 1*. Permission to conduct research at Inaccessible Island was granted by the Administrator, Brian Baldwin, and the Tristan Island Council. Banding records were administered efficiently by SAFRING. John Cooper, John Croxall, Mike Fraser and an anonymous referee provided useful comments on an earlier draft. PGR is grateful to the University of Cape Town for sabbatical leave, and CLM to Marine and Coastal Management for a special leave of absence.

REFERENCES

BERROW, S.D. 2000. The use of acoustics to monitor burrow-nesting White-chinned Petrels *Procellaria aequinoctialis* at Bird Island, South Georgia. *Polar Biol.* 23: 575–579.

BIRDLIFE INTERNATIONAL. 2000. Threatened birds of the world. Barcelona & Cambridge: Lynx Edicions & BirdLife International.

COLLAR, N.J. 1999. Risk indicators and status assessment in birds. In: del Hoyo, J., Elliott, A. & Sargatal, J. (Eds). Handbook of the birds of the world. Vol. 5. Barn-owls to hummingbirds. Barcelona: Lynx Edicions. pp. 13–28.

COOPER, J. & FRASER, M.W. 1988. Bird ringing at Tristan da Cunha islands, 1982–1985. *S. Afr. J. Antarct. Res.* 16: 38–40.

ELLIOTT, H.F.I. 1957. A contribution to the ornithology of the Tristan da Cunha group. *Ibis* 99: 545–586.

FRASER, M.W., RYAN, P.G. & WATKINS, B.P. 1988. The seabirds of Inaccessible Island, South Atlantic Ocean. *Cormorant* 16: 7–33.

GIBBONS, D.W. & VAUGHAN, D. 1998. The population size of Manx Shearwater *Puffinus puffinus* on 'The Neck' of Skomer Island: a comparison of methods. *Seabird* 20: 3–11.

HAGEN, Y. 1952. Birds of Tristan da Cunha. *Res. Norw. Sci. Exped. Tristan da Cunha 1937–38* 20: 1–248.

HAGEN, Y. 1982. Migration and longevity of Yellow-nosed Albatrosses *Diomedea chlororhynchos* banded on Tristan da Cunha in 1938. *Ornis Scand.* 13: 247–248.

JAMES, P.C. & ROBERTSON, H.A. 1985. The use of playback recordings to detect and census nocturnal burrowing seabirds. *Seabird* 8: 18–20.

MORANT, P.D. 1977. Bird ringing at Tristan da Cunha and Gough Islands, 1937–1977. *S. Afr. J. Antarct. Res.* 7: 23–26.

MOSELEY, H.N. 1892. Notes by a naturalist, being an account of various observations made during the voyage of H.M.S. *Challenger* round the world in the years 1872–1876. London: Macmillan.

OLMOS, F., BASTOS, G.C.C. & NEVES, T. da S. 2000. Estimating seabird bycatch in Brazil. In: Flint, E. & Swift, K. (Eds). Second International Conference on the Biology and Conservation of Albatrosses and other Petrels, Honolulu, Hawaii, USA, 8–12 May 2000. Abstracts of oral and poster presentations. *Mar. Orn.* 28: 141.

ROUX, J.P., RYAN, P.G., MILTON, S.J. & MOLONEY, C.L. 1992. Vegetation and checklist of Inaccessible Island, central South Atlantic Ocean, with notes on Nightingale Island. *Bothalia* 22: 93–109.

ROWAN, A.N., ELLIOTT, H.F.I. & ROWAN, M.K. 1951. The 'spectacled' form of the Shoemaker *Procellaria aequinoctialis* in the Tristan da Cunha group. *Ibis* 93: 169–179.

RYAN, P.G. 1998. The taxonomic and conservation status of the Spectacled Petrel *Procellaria conspicillata*. *Bird Conserv. Int.* 8: 223–235.

RYAN, P.G., COOPER, J. & GLASS, J.P. 2001. Population status, breeding biology and conservation of the Tristan Albatross *Diomedea [exulans] dabbenena*. *Bird Conserv. Int.* 11: 33–46.

RYAN, P.G., DEAN, W.R.J., MOLONEY, C.L., WATKINS, B.P. & MILTON, S.J. 1990. New information on seabirds at Inaccessible Island and other islands in the Tristan da Cunha group. *Mar. Orn.* 18: 43–54.

RYAN, P.G. & FRASER, M.W. 1988. The use of Great Skua pellets as indicators of plastic pollution in seabirds. *Emu* 88: 16–19.

RYAN, P.G. & MOLONEY, C.L. 1991. Prey selection and temporal variation in the diet of Subantarctic Skuas at Inaccessible Island, Tristan da Cunha. *Ostrich* 62: 52–58.

SIDDALL, C.P. 1985. Survey of Inaccessible Island, Tristan da Cunha group. *Polar Rec.* 22: 528–531.