POPULATION SIZE, DISTRIBUTION AND ORIGINS OF ANTARCTIC TERNS *STERNA VITTATA* WINTERING IN SOUTH AFRICA

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SUMMARY

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A survey of the South African coastline in August 2001 gave a total of *c.* 9584 Antarctic Terns *Sterna vittata.* A minimum corrected figure to include birds remaining at sea during inclement weather came to about 12 800 birds. Numbers in the Eastern Cape showed an apparent increase from earlier counts made in the 1970s and 1980s, whereas those for three sections of the Western Cape showed apparent declines. Overall there appears to have been a decline in numbers. Four subspecies are recognized as visiting South African waters: nominate *vittata* and *sanctipauli* (Indian Ocean) and *tristanensis* and *georgiae* (Atlantic Ocean). The distribution of these subspecies around the coastline was tentatively assessed. Birds were found to concentrate around the cluster sites of Bird Island, Eastern Cape, and Dyer and Malgas islands, Western Cape, with Dyer Island the major site for *tristanensis.* There was little indication of movement between each of the cluster sites. Data assembled from a four-year banding/flagging study (1998–2001) of the Antarctic Tern on Bird Island indicate that productivity during this period was very low and unlikely to sustain the population; it may be indicative of a long-term decline. Breeding figures for the Indian Ocean may be too low; those for *tristanensis* may be fairly accurate. The subspecies *georgiae* appears to be a sparse visitor to South Africa. Factors determining count sizes at major sites are investigated.

Key words: Antarctic Tern, *Sterna vittata*, wintering, populations, migration

INTRODUCTION

The Antarctic Tern *Sterna vittata* is a moderately common winter visitor to restricted stretches of the coastline and offshore islands of the Western and Eastern Cape provinces of South Africa. Within that region it is found at specific sites in the Western Cape between St Helena Bay and Cape Agulhas and in the Eastern Cape from Cape St Francis to Bird Island, Algoa Bay. Between these two specified coastal zones, it may be recorded offshore, but there are no onshore records. Farther east in the Eastern Cape and KwaZulu–Natal, as well as farther north along the west coast, it is a rare visitor. The birds first arrive in May, reach peak numbers in July/August and have mostly departed by the end of October; very small numbers have been found over-summering in the Western Cape. Cooper (1976) made the first assessment of wintering numbers on the South African coastline based on counts from the years 1971 to 1976. Brooke *et al.* (1988) attempted a more detailed assessment drawn from counts made between 1971 and 1986, incorporating those of Cooper (1976). All these counts were made during the day. In both cases counts were scattered over the period June to November. No previous attempt has been made to visit all sites within a single season and over a fairly restricted time span.

METHODS

The Antarctic Tern has been the subject of a long-term study on Bird Island, Algoa Bay, since 1998. The results led the authors to attempt a full South African assessment during the course of a single winter. Bird Island was visited during 9–13 July and 20–24 August 2001, and mainland counts were made farther west at Cape Recife in Algoa Bay during June–October. The Western Cape coastline, including Dyer and Dassen islands, was visited from 23 July to 9 August 2001 (Table 1). Certain less important sites listed by Cooper (1976) and Brooke *et al.* (1988) were not visited owing to problems of access, but these sites rarely hold birds nowadays (P.A.R. Hockey pers. comm.). Counts were made during the day at all sites, although on Bird, Dyer and Dassen islands they were counted several times up to last light because there was a steady build-up in numbers from late morning until dark at the first two sites, but a decline from early afternoon at Dassen Island. On the first two mentioned islands, birds were noted arriving until long after dark, this being determined both by mist-netting and, on Bird Island, by sightings in the lighthouse beam or against a moonlit sky. Mist-netting, using single-shelf nets, was carried out principally in the evening and at night on both islands, with a few birds being caught amongst shoreline rocks during the day at low tide. Once birds settle into a nocturnal roost site they tend not to move unless disturbed, usually by the incoming tide.

During the winters of 1998–2001, 1118 birds were banded on Bird Island; 924 of these were also colour flagged. On Dyer Island 132 birds were banded and flagged in late July 2001. One of these had been banded, but not flagged, in August 1999 on Bird Island. Bird Island–banded Antarctic Terns carry a stainless steel metal band on the right leg and a yellow plastic (Darvic) flag on the left leg, this latter replaced by a white flag on Dyer Island birds. An attempt to catch birds on Dassen Island was unsuccessful, because on the one night during which roosting took place, the birds, which

were very restless anyway, moved when we set the nets. Table 2 gives a breakdown of the numbers of adults and juveniles banded each season, giving a rough annual productivity figure for each of the years 1998–2001.

An attempt was made to assess the relative proportions of the subspecies occurring in South Africa (Table 3). There is some confusion in the literature as to the number and form of subspecies and their distribution (e.g. Murphy 1938, Urban *et al.* 1986, del Hoyo 1996, the late R.K. Brooke unpubl. data). We have dealt with subspecific differentiation based on plumage, biometrics (Table 4) and moult. The darkest birds are nominate *vittata* from the more southerly Indian Ocean populations of Kerguelen and Heard islands. Pale, similarly-sized *sanctipauli* are from the most northerly Amsterdam and St Paul islands. A number of intermediates between the former two subspecies possibly come from the Crozet and Prince Edward island groups. In the Atlantic Ocean, large pale *tristanensis* are from Tristan da Cunha and Gough islands. The small, darker *georgiae* come from South Georgia, South Orkney and South Sandwich islands and possibly Bouvet. The first three subspecies can be separated in the field with care and experience, but the smaller *georgiae* can be separated safely only in the hand and may also be confused with the Arctic Tern *S. paradisaea.* Some moulting *sanctipauli* and *tristanensis* may not be separable in the field, because identification is based on tail length and earlier assumption of breeding dress. However, the indication from birds caught on Dyer and Bird islands is that *tristanensis* moults earlier than the other subspecies present, hence standing out in the winter flocks.

The term 'cluster sites' is used to describe the most-commonly used islands at which Antarctic Terns roost at night, together with the nearby mainland localities utilized as diurnal roosts. The three cluster sites presently in use are those of Bird, Dyer and Malgas islands (Fig. 1).

Separation of Antarctic and Common Terns *S. hirundo* in the field is quite easy with experience. Adult Antarctic Terns show a pot-bellied appearance, both while sitting and in flight. They also have pale wings lacking dark outer primaries or noticeable carpal bar; a more rounded head with more extensive white; grey to mottled grey and white underparts (rarely fully white); shorter, stockier legs; and a heavier bill that shows varying degrees of red and black in the adult. Second-year birds are as adults, but have white underparts and a black bill. Juveniles are diagnostic with their heavily patterned upperparts of which the mantle moults to adult grey during the course of the austral winter/spring. The Common Tern is sleeker, giving a more chesty appearance, especially in flight. Adults have dark outer primaries, whereas one-year-olds do not show this, but have a pronounced dark carpal bar; white to very pale grey underparts; a flatter head; longer, thinner legs; and a slimmer, black bill when not breeding.

TABLE 1
Maximum counts at diurnal (D) and nocturnal (N) roosts of Antarctic Terns in the Western and Eastern Cape provinces, South Africa, winter 2001

Roost site[1]		Roost environment	Maximum count	Date
		Western Cape Province		
Groot Paternoster Point	(32°44′S, 17°53′E)	Sand/rock (D)	430	1 August
Bekbaaie	(32°48′S, 17°52′E)	Sand (D)	39	1 August
Voel Eiland	(32°53′S, 17°52′E)	Rock (D)	31	1 August
Mauritz Bay	(32°58′S, 17°53′E)	Rock (D)	430	1 August
Danger Bay	(33°01′S, 17°54′E)	Sand (D)	0	1 August
Klein Eiland	(33°09′S, 18°00′E)	Sand (late D)	540	31 July
Dassen Island	(33°25′S, 18°05′E)	Sand (D)	1170	4 August
Kommetjie	(34°08′S, 18°19′E)	Rocks (D)	4	30 July
N of Oliphantsbos	(34°14′S, 18°22′E)	Rocks (D)	0	6 August
Oliphantsbos	(34°15′S, 18°22′E)	Rocks (D)	0	6 August
Hoek van Bobbejaan	(34°19′S, 18°24′E)	Rocks (D)	0	6 August
Platboompunt	(34°20′S, 18°26′E)	Rocks (D)	0	6 August
Cape Point	(34°21′S, 18°28′E)	Rocks (D)	0	6 August
Diaz Point	(34°21′S, 18°28′E)	Rocks (D)	0	6 August
Danger Point	(34°37′S, 19°17′E)	Rocks (D)	900	29 July
Dyer Island	(34°40′S, 19°25′E)	Rocks (N)	2600+	27 July
Buffeljag Baaie	(34°44′S, 19°36′E)	Rocks (D)	0	7 August
Rasperspunt (C Agulhas)	(34°49′S, 19°58′E)	Rocks (D/N)	0	7–8 August
		Eastern Cape Province		
Bird Island	(33°51′S, 26°17′E)	Rocks/sand (N)	4000+	10 July
Cape Recife	(34°02′S, 25°42′E)	Rocks/sand (D)	340	9 October
Cape St Francis	(34°12′S, 24°59′E)	Rocks (D)	0	July/September

[1]Roost sites not visited but mentioned in Brooke *et al.* (1988) were Bird Island, Lambert's Bay; Elandsbaai; Shell Bay; Hospital Bay; North Head; Marcus Island; Stofbergsfontyn beach; Koeberg power station; Quoin Point; and Brenton Rock. Most of these sites rarely contain Antarctic Terns nowadays (P.A.R. Hockey pers. comm.).

RESULTS

Counts

A total of 9584 Antarctic Terns was counted in 2001, omitting the Danger Point count of 900 birds (Table 1). The Danger Point day roost was composed of birds that are thought to have roosted at night at Dyer Island, as evidenced by more than 4% white-flagged birds present and would thus represent duplication. This figure is close to 5% of the peak count banded/flagged at that island.

Table 2 gives a breakdown of the numbers of adults and juveniles banded on Bird Island each season. From this is derived a rough estimate of fledging success for each of the years 1998–2001. Because juvenile terns arrive only from July, it is assumed that they have already suffered half of their potential first-year mortality. Table 3 shows a rough breakdown of the distribution of the subspecies of the Antarctic Tern around the South African coast, based on visual and banding data. The counts of Indian Ocean birds from the three main cluster sites give a total of 7040 birds. By increasing this total with those remaining at sea, a potential figure of 9240 is obtained.

TABLE 2
Numbers of adult and juvenile Antarctic Terns banded on Bird Island 1998–2001. Potential survival of banded birds to 2001 shown

Year	Months (n)	Adult (n)	Juvenile (%)	Juvenile (n)	Potential Surviving to 2001
1998	July, September–October	76	1	1.3	55
1999	June, August–September	(297)[1] 229	24	10.5	(257)[1]
2000	July–September	527	32	6.1	498
2001	July–August	115	46	39.7	161
Total		1015	103	10.9	971–1118

[1]Figure in parentheses includes adults caught in June, before arrival of juveniles. Final figure based on that total, percentage juveniles based on the second figure. Suggested post-fledgling mortality rates of 50% for birds in their first year and 10% per year thereafter. Because first-year birds arrive in South Africa from July, it is also suggested that half of the annual mortality rate has already occurred.

South African distribution

Three islands form cluster sites from which birds radiate out during the day, returning to roost at night. These are Bird and Dyer islands on the south coast and Malgas Island on the west coast.

Bird Island cluster

The Bird Island cluster incorporates Cape Recife, the principal mainland site, and Cape St Francis, where the bird is scarce, with no records to the west of that point and very few to the east of Bird Island. The distance from Bird Island to Cape Recife is 65 km. To Cape St Francis is a further 73 km, the latter probably outside the normal daily foraging range.

Dyer Island cluster

This cluster incorporates Danger Point, the principal mainland site, Buffeljagsbaai, Quoin Point and Rasperspunt at Cape Agulhas. At the last three sites, the occurrence of birds is erratic. Danger Point lies 9 km from Dyer Island and Rasperspunt is some 40 km distant.

Malgas Island cluster

At present the only known west coast nocturnal roost site is Malgas Island, Saldanha Bay, where in winter 2001 roost numbers were in excess of 1500 birds, many of which were roosting on the roofs of buildings (B.M. Dyer pers. comm.). Dassen Island does not appear to be a normal nocturnal roost site (J. Cooper & J. Visagie pers.

TABLE 3
Distribution of Antarctic Tern subspecies along the South African coast during the 2001 survey

Locality	Count	Proportion of subspecies
Bird Island	4000	80% *vittata,* balance *sanctipauli* and/or intermediates, occasional *tristanensis,* mainly in July, *georgiae* rarely
Dyer Island	2600	85% *tristanensis,* remainder *vittata,* some *sanctipauli,* a few *georgiae*; *tristanensis* and *vittata* formed separate nocturnal roosts with some intermixing
Kommetjie	4	*sanctipauli*
Klein Eiland	540	Mainly *vittata,* ±5% *sanctipauli*
Groot Paternoster Point	430	Mainly *vittata* with ±10% *sanctipauli*
Mauritz Bay	430	30% *vittata,* 70% *sanctipauli*
Dassen Island	1170	95% *vittata,* 5% *sanctipauli*

TABLE 4
Biometrics from breeding grounds of Antarctic Tern subspecies visiting South Africa (after the late R.K. Brooke unpubl. data)

Subspecies	Wing (mm)[1]	Tail (mm)[1]	Culmen (mm)[1]	Tarsus (mm)[1]	Mass (g)[1]
vittata	260–286 (10)	119–153 (12)	31.8–34.8 (12)	17.0–19.0 (12)	
sanctipauli	236–263 (33)	125–187.5 (20)	33–40 (37)	17.5–20.5 (36)	124.5–158.7 (9)
tristanensis	240–270 (34)	150–206 (35)	33.6–42.1 (30)	18.4–21.4 (36)	
georgiae	246–270 (26)	121–137.5 (26)	28.5–32.8 (26)	15.9–17.8 (26)	

[1]Sample sizes are given in parentheses.

comm.), although small numbers stayed over on one night during a gale on our 2001 visit. Birds found to the north and south of Saldanha Bay presumably all roost on Malgas Island. Groot Paternoster Point was not used as a nocturnal roost site (F. van der Westhuizen pers. comm.), and Klein Eiland and Vondeling Island are not utilized either (K. Harrison pers comm). All these sites lie within 40 km of Malgas Island.

Southwest coast cluster

Robben Island has never been recognized as a site for Antarctic Terns, and so it is not clear where birds that formerly occurred along the Cape Peninsula coast would have roosted at night. In 1979 Kommetjie held the largest mainland concentration, with 1200 birds on 16 September (Brooke *et al.* 1988), but by 2001 the species had become a rarity at this locality.

Despite intensive searching for colour flags and bands in the Western Cape in 2001, only two marked Bird Island birds were seen (but not caught) in addition to the bird from Bird Island recaptured on Dyer Island. One was seen on Dyer Island and another at Mauritz Bay, on the west coast on 1 August 2001. Both bands appeared to be of the same type as those used on Bird Island.

DISCUSSION

Population size and distribution

At the west-coast sites to the south of Cape Town, 1454 birds were counted in the previous survey, as against four in this study; whereas, at the sites to the north of Cape Town, 7180 birds were counted earlier as against 2640 in 2001. At the Dyer Island cluster sites, 4112 were found earlier as against 2600+ (Danger Point excluded) in 2001. Diurnal Antarctic Tern counts on Dyer Island have rarely reached 1500 birds in recent years (A.J. Venter pers. comm.). In 1977 a peak count of 4500 was made on Dassen Island against a peak of 1170 in 2001. Nowadays diurnal counts normally do not exceed 600 birds at this island and are usually much less (J. Visagie pers. comm.). The distribution of Antarctic Terns in South African inshore coastal waters (Fig. 1) appears to be determined by the presence of suitable offshore islands on which to roost at night. However, the species is recorded widely in waters up to the continental shelf, often more than 150 km from land, from Cape Hondeklip (30°N) on the west coast to Port Elizabeth in the east. Some, at least, roost at sea, either on floating wood or kelp *Ecklonia maxima* stipes (Sinclair 1978, Brooke *et al.* 1988).

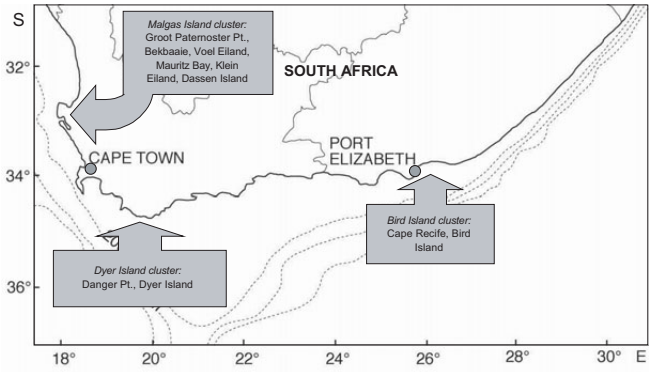

Fig. 1. Cluster sites where Antarctic Terns were recorded on the South African coastline in 2001. Excluded are sites where fewer than five birds were recorded.

The total world population of the Antarctic Tern is approximately 44 500 breeding pairs (Table 5). About 92% of this total is found in the Atlantic sector of the Southern Ocean, chiefly on the South Shetland Islands. An estimated 2615 pairs breed on the southern islands of the Indian Ocean, giving a total adult figure of 5230. Estimates of the number of non-breeders are difficult to make with any degree of accuracy. The closest that we can find for the 1998–2001 period is by use of banding data from Bird Island (Table 1). For each of the four years, the total of adults banded is compared to that of juveniles, the latter shown as a percentage of the total. Because juveniles arrive only from July, the number of June-banded adults in 1999 is subtracted from the total to obtain a more accurate juvenile proportion. It is not known at what age Antarctic Terns commence breeding; but, given that most Arctic Terns breed at four years (Cramp 1985), a similar age is used here. Mortality rates in terns are also difficult to obtain from the literature and a figure of 52.3% mortality within the first year of life is given for the larger Gull-billed Tern *Gelochelidon nilotica* in Europe. A long-term study of a declining Roseate Tern *S. dougallii* population in North America indicated that about 16% of fledged young reached breeding age (three years) and adult survival was about 0.74–0.84 per year (Spendelow 1991, Spendelow *et al.* 1995). The oldest known Roseate Tern is 25.6 years (Gochfeld *et al.* 1998). In the Common Tern, estimates for survival from fledging to breeding vary widely, depending on scope and methodology. In a German study, survival was 42% to three years and 22% to four years (Wendeln & Becker 1998, cited in Nisbet 2002), and the oldest known bird was a banded chick recovered at 28 years, 3 months of age in Namibia (Helgoland databank).

TABLE 5
Estimates of Antarctic Tern breeding populations (pairs) and whether they are considered long-distance migrants[1]

Locality	Breeding pairs (n)	% of world total	Migratory status
Antarctic Peninsula	1500	3.37	No
South Shetland Islands	35 000	78.7	No
South Orkney Islands	500	1.12	Yes
South Sandwich Islands	100	0.22	Unknown
South Georgia	2500	5.62	Partial
Tristan da Cunha & Gough islands	1150	2.59	Yes
Bouvet Island	50	0.11	Probably
Atlantic Ocean total	*40 800*	*91.75*	
Amsterdam & St Paul islands	400	0.90	Yes
Prince Edward Islands	<15	<0.03	Yes
Crozet Islands	100	0.22	Yes
Kerguelen Island	2000	4.50	Yes
Heard Island	100	0.22	Yes
Indian Ocean total	*2630*	*5.91*	
Macquarie Island	40	0.09	No
Southern New Zealand islands	1000	2.25	No
Pacific Ocean total	*1040*	*2.34*	
World total	**44 455**		

[1]Information sources: Convey *et al.* 1999, Croxall *et al.* 1984, Higgins & Davies 1996, Jouventin 1994, Rootes 1988, Segonzac 1972, Crawford & Cooper 2003, E.J. Woehler pers. comm., B.M. Dyer pers. comm., P.G. Ryan pers. comm.

Potential longevity in the Antarctic Tern may be higher because 34 years has been recorded for the Arctic Tern (Hatch 2002). Mortality figures of 50% are assumed here for first-year birds and 10% per year thereafter for the Antarctic Tern. The latter equates with figures of 7%–13% per year given for the Common Tern (Cramp 1985, Nisbet 2002).

In using banding statistics to estimate the population size of Indian Ocean birds during 1998–2001, the numbers of non-breeders (one to four years of age) appear to be very low. The figures shown in Table 2 indicate that non-breeders in 2001 (this related to potential survival of young from 1998–2001) may have added a further 10.9% to the suggested breeding population of 5260 indicated in Table 5 (≥ four-year-old birds), giving an overall figure of 5835. The inferred total of 9240 from the counts made in 2001 (Table 1) is much larger than this figure. Either the totals of breeding birds for the Indian Ocean islands are seriously underestimated (and this is likely for Kerguelen which is large, with many offshore islets, and difficult to survey in its entirety in any given year), or the numbers remaining at sea are much higher than we estimate here. Further possibilities are that many birds may not normally breed until they are five or six years of age or that a varying percentage of individuals may not breed every year, thus increasing the potential number of non-breeders. Obviously one or more of these factors comes into play, but all indications are that South Africa plays host to virtually the entire non-breeding population of Indian Ocean Antarctic Terns. Very small numbers of birds also spend the austral winter at the sub-Antarctic breeding islands of Marion and Prince Edward (Burger 1978) and presumably at the more northerly Amsterdam and St Paul Islands.

The breeding population of *tristanensis* from Tristan da Cunha and Gough Islands is estimated at 800–1500 pairs (P.G. Ryan pers. comm.), making it difficult to arrive at a satisfactory figure of population size. However, in taking a mid-estimate of 1125 pairs, a total of adults would be 2250, to which may be added non-breeders and potential birds remaining at sea. In August 2001 on Dyer Island, the first-year birds of this subspecies caught constituted 19.7% of the total catch and second-year birds, a further 11.4%. This still indicates a low productivity, possibly commensurate with that of the Indian Ocean birds. Thus, using the Indian Ocean figure of 10.9% non-breeders, the adult population would be boosted to about 2500 birds. Adding birds at sea would give a total of more than 3300. Based on the peak count of 2200 for this subspecies at Dyer Island, together with birds remaining at sea, a figure of 2950 is proposed. The numbers remaining on the breeding islands are unknown. This latter figure is not far removed from the figure of 3300 and indicates that Dyer Island is of extreme importance as a non-breeding resort for the bulk of the subspecies *tristanensis.*

In Brooke *et al.* (1988), an aggregated total of 13 732 birds is given for South African waters, and it was suggested that the entire population was in excess of 15 000 birds. In the 2001 survey the aggregated count came to 9584 birds. When corrected for possible birds remaining at sea, this total would be in the region of 12 800. The 2001 total for the Eastern Cape sites has shown a huge apparent increase from 649 to 4340+, whereas that for the Western Cape shows an apparent decrease, with peak numbers on Dassen and Dyer Islands well down from those of 1977 and 1983. W. Suter (pers. comm.) suggests that the figure of 600 was the norm for Dassen Island in 1983 and 1984, admitting, however, that turnover during the day was high. Discussions with P.A.R. Hockey and P.G. Ryan of the University of Cape Town indicate that a decline in Antarctic Terns in the southwestern section of the Western Cape has been ongoing for some years and that Kommetjie holds few birds nowadays. In the case of the Eastern Cape, the earlier result was partly based on a single count made on Bird Island at an unknown time of day in early August 1979. During this era, Bird Island was frequented by a substantial number of guano workers, who resided on the island from May to July each year, together with permanently resident lighthouse personnel. The effects of this human population on the over-wintering Antarctic Terns is unknown, but given that the breeding Roseate Tern, which forms an important magnet for roosting terns (pers. obs.), was partially driven from the island (Randall & Randall 1978), it is likely that Antarctic Tern numbers were also affected. The island became a provincial nature reserve in 1987, and guano collection ceased in 1989. The true importance of this site was not realized until the 1990s when a series of counts made by island headmen (Eastern Cape Nature Conservation records) and the authors indicated a varying annual peak of 4000–5000 birds. The presence of substantial, but unknown, numbers at the Cape Recife nocturnal tern roost in 1971 (AJT pers. obs.) may have reflected this earlier disturbance.

It would appear from the figures given in Table 2 that Antarctic Tern productivity is very low in most years unless numbers of juveniles do not make landfall in their first year; but this seems unlikely, because they would have a greater need of a secure resting site. There is no indication of an increase in second-year birds in the succeeding seasons. Low productivity has been suggested for Heard Island (del Hoyo *et al.* 1996) and may apply more widely with nest predation being high on the Antarctic Peninsula (Murphy 1938). A more realistic figure for adult mortality may be 10% a year. The apparent low productivity of young surviving to reach South African waters, averaging about 11% per year during 1998–2002, is a cause for concern and may be evidence for a long-term decline. The factors governing this are unclear and may reflect conditions on the breeding grounds or during migration. Feeding conditions in South African waters have been very good for several years with Anchovy *Engraulis japonicus* stocks at a high level (Marine & Coastal Management 2001).

The normal distance that birds will fly to a suitable roost site is unknown, but it is unlikely to be much more than 80 km. (Bird Island is 65 km from the diurnal roost site at Cape Recife.) Equally unknown is their daily foraging distance out to sea. Antarctic Terns have been recorded feeding to the edge of the continental shelf (Ryan & Rose 1987) and at considerable distances from cluster sites. The impression gained at Bird Island is that many individuals may return to roost only every second or third day. This was suggested on Bird Island in 1999 when the first colour flagging took place and the numbers of flagged individuals fluctuated from day to day. No flagged birds were seen on the day following the first night's banding, and few by the second day. No birds were ever recaptured within a few days of banding. Birds found in the vicinity of Cape St Francis may join a mixed tern roost near to the Kromme River mouth rather than attempt to fly the 140 km to Bird Island. The small numbers of birds that travel farther north from St Helena Bay, on the west coast, probably join the tern roost at Bird Island, Lambert's Bay, where they have been occasionally recorded (Brooke *et al.* 1988, V.C. Ward pers. comm.).

Count results need to be assessed in conjunction with the prevailing weather at the time. In calm conditions reduced numbers of birds come to islands to roost, either diurnally or nocturnally, whereas during spells of very strong winds peak numbers are recorded. The peak counts shown for Bird, Dyer and Dassen islands were made during periods of near gale to gale conditions, whereas counts on calmer days during the same periods were reduced by 35%–80%. Other problems that may arise in assessing nocturnal roost sites are (1) that many birds continue to arrive well after dark, (2) that counting massed tern flocks is difficult, especially in poor light conditions and (3) that from mid-August many Common Terns are also likely to be present. This last problem applies particularly to Dyer Island, which holds a major nocturnal Common Tern roost site as the summer season progresses (A.J. Venter pers. comm.)—although the September 1983 total of 4000 Antarctic Terns was carefully assessed, and the number of Common Terns then present was small (W. Suter pers. comm.). Owing to much diurnal movement, aggregate counts—even over a very short period of time—may not give an accurate assessment of each cluster group. Concordant counts at nocturnal roost sites in different weather conditions would give a far better indication of total numbers.

A further unknown long-term effect is that of varying fish stocks in the vicinity of each cluster point. African Penguin *Spheniscus demersus* populations at Dyer Island increased during the period 1956–1980, while those at localities between Dassen Island and Lüderitz, Namibia, decreased. The increase at Dyer Island was too rapid to have resulted from productivity on the island, and it was thought that there was considerable immigration of first-time breeders from colonies to the north. The increase at Dyer Island coincided with an increased abundance of Anchovy off South Africa. After 1980 the colony of penguins at Dyer Island decreased rapidly as the Anchovy stock decreased. As at Possession Island during the 1950s and 1960s, the rate of decrease was similar to what would be expected from adult mortality in the absence of recruitment of young breeders to the population (Crawford 1998, Cordes *et al.* 1999, Crawford *et al.* 2001). Anchovy are a major food item of the Antarctic Tern (pers. obs.), and local fluctuations in prey density are likely to have an impact on tern numbers.

Origins, subspecies and local movements

The present apparent distribution of subspecies of the Antarctic Tern at South African coastal roosts is shown in Table 3. Sub-specific identification is based on both biometrics (Table 4) and plumage. This distribution is partially supported by banding recoveries: a bird banded on Dyer Island was recovered on Gough Island in the Atlantic Ocean, and one from Dassen Island on Kerguelen Island in the southern Indian Ocean (Underhill *et al.* 1999). To date, there have been five sightings of Bird Island–flagged birds and two with bands only (presumably from Bird Island) from Heard Island, southeast of Kerguelen (Tree 2001). The surprising finding here is that Dyer Island hosts the large majority of the *tristanensis* population. A few birds find their way to Bird Island and probably up the west coast as well. Also unexpected was that the Atlantic and Indian Ocean birds, to a great extent, formed separate roosts on Dyer Island. The sub-specific status of the world population is in need of reassessment, and our choice of the four subspecies shown above should not be taken as final, but as an effort to separate the different sub-populations visiting South African shores.

There is scant evidence of movement between the Eastern and Western Capes. Analysis of earlier banding data gave the impression that *ortstreue,* birds returning to the same site in successive seasons, was strongly developed in this species (Underhill *et al.* 1999). This is very apparent on Bird Island, with the exceptionally high return of banded birds each season. However, the possibility of longer-term shifts of the population around the coast depending on the availability of good food resources should not be discounted.

Population trends

A factor that must be considered in the evaluation of the older Western Cape counts is that any counts from mid-August will have an increasing content of Common Terns that can be easily overlooked in densely packed flocks. This factor has been taken into account on Bird Island, and the relative proportions were checked (using binoculars for closer viewing) while birds were flying into the roost site. In flight, even as silhouettes, the two species are quite easily separated with experience. Also, the use of peak counts from sites at different stages of the day and of winter and from different years does not take into account any daily or seasonal movement within non-breeding quarters. However, earlier counts were all made during the day when numbers would not have reached their peak as they do at nocturnal roosts. Despite this, the almost total lack of birds on the west coast to the south of Cape Town and the reduced overall totals for the Western Cape do suggest a decline that begs to be monitored at regular intervals in the future. It is possible that the apparent decline of birds in the Western Cape may be partially balanced by the increase in the Eastern Cape. At present there is no suggestion that birds have declined at the more southerly Indian Ocean islands, but there are indications of a decline in breeding populations at both the Prince Edward Islands (Crawford & Cooper 2003, Crawford *et al.* 2003) and Amsterdam and St Paul islands. At Amsterdam and St Paul islands, earlier figures indicate the total population at 1200 pairs, whereas more recent figures indicate a total of 400 pairs. Rats *Rattus* spp. and feral cats *Felis catus* on the islands are probably the cause of this decline (Croxall *et al.* 1984, Jouventin 1994). The Antarctic Tern once bred on the main island of Tristan da Cunha but is now restricted to rat-free islands within the group (P.G. Ryan pers. comm.). The decline in numbers at Dyer Island could be representative of the decrease recorded in either or both oceanic populations.

At present there are three isolated cluster sites: those of Bird Island, Dyer Island and the Malgas Island/Saldanha Bay area. The importance of each of these cluster sites cannot be overemphasised, because the vast majority of the Indian Ocean and the more northerly Atlantic Ocean birds concentrate at these sites. Fortunately, the three cluster sites are protected by provincial and national nature conservation bodies.

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