POPULATION TRENDS OF SEABIRDS BREEDING IN SOUTH AFRICA'S EASTERN CAPE AND THE POSSIBLE INFLUENCE OF ANTHROPOGENIC AND ENVIRONMENTAL CHANGE

ROBERT J.M. CRAWFORD,[1,2] PHILIP A. WHITTINGTON,[3,4] A. PAUL MARTIN,[5]
ANTHONY J. TREE[4,6] & AZWIANEWI B. MAKHADO[1]

[1]*Department of Environmental Affairs and Tourism, Marine and Coastal Management, Private Bag X2, Rogge Bay, 8012, South Africa (crawford@deat.gov.za)*
[2]*Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch, 7701, South Africa*
[3]*East London Museum, PO Box 11021, Southernwood, 5213, South Africa*
[4]*Department of Zoology, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031, South Africa*
[5]*PO Box 61029, Bluewater Bay, 6212, South Africa*
[6]*PO Box 211, Bathurst, 6166, South Africa*

Received 28 August 2008, accepted 4 April 2009

SUMMARY

CRAWFORD, R.J.M., WHITTINGTON, P.A., MARTIN, A.P., TREE, A.J. & MAKHADO, A.B. 2009. Population trends of seabirds breeding in South Africa's Eastern Cape and the possible influence of anthropogenic and environmental change. *Marine Ornithology* 37: 159–174.

Eleven species of seabird breed in South Africa's Eastern Cape Province. Numbers of African Penguin *Spheniscus demersus* and Cape Gannet *Morus capensis* in the province increased in the 20th century, but penguins decreased in the early 21st century. A recent eastward displacement of Sardine *Sardinops sagax* off South Africa increased the availability of this food source to gannets but did not benefit penguins, which have a shorter foraging range. Fishing and harbour developments may have influenced the recent decrease of penguins. Cape Cormorant *Phalacrocorax capensis* and Swift Tern *Thalasseus bergii* also feed on sardine and increased in the Eastern Cape in the early part of the 21st century. There has been a recent increase in the Kelp Gull *Larus dominicanus* population in South Africa's Indian Ocean sector, which includes the eastern portion of the Western Cape Province. Hartlaub's Gull *L. hartlaubii* and Damara Tern *Sterna balaenarum,* which have their main populations in the Benguela system off western southern Africa, were first recorded in the Eastern Cape in the late 1970s and later shown to be breeding there. Numbers of White-breasted Cormorant *P. lucidus* and Caspian Tern *Hydroprogne caspia* breeding in this province have been stable, but those of Grey-headed Gull *L. cirrocephalus* and Roseate Tern *St. dougallii* have increased since the early 1990s. The former three species also breed at inland localities; the Roseate Tern is at the western extent of its distribution in the Indian Ocean. Although not yet breeding in the Eastern Cape, the Crowned Cormorant *P. coronatus,* another western species, has extended its range to this province. Congruent changes in the distributions and abundance of several marine species off South Africa, and similar changes elsewhere in the Indian Ocean, suggest that large-scale environmental change may be influencing the distribution and abundance of species. Conservation will need to account for these as well as for anthropogenic impacts.

Key words: Cormorants, gannets, gulls, penguins, terns, population trends, range expansion, eastern South Africa

INTRODUCTION

Islands off the coast of southern Africa used by seabirds for breeding are grouped into three regions: those off southern Namibia, off South Africa's Western Cape and in Algoa Bay, Eastern Cape (Fig. 1). The islands in Algoa Bay are separated from those in the Western Cape by about 600 km (Underhill *et al.* 2006) and by Cape Agulhas, Africa's southernmost point, which divides the Atlantic Ocean to the west from the Indian Ocean to the east. In all three regions, and in KwaZulu–Natal farther east, seabirds also breed at mainland localities.

The occurrence of seabirds at islands in Algoa Bay was reviewed by Randall *et al.* (1981), who recorded eight breeding species: African Penguin *Spheniscus demersus,* Cape Gannet *Morus capensis,* Cape Cormorant *Phalacrocorax capensis,* White-breasted Cormorant *P. lucidus,* Kelp Gull *Larus dominicanus,* Caspian Tern *Hydroprogne caspia,* Roseate Tern *Sterna dougallii* and Swift (Crested) Tern *Thalasseus bergii.* There are six islands in Algoa Bay on which seabirds breed: Jahleel, Brenton and St. Croix in the west; the St. Croix Island group; and Seal, Stag and Bird in the east, the Bird Island group. Seal and Stag may be joined at low tide (Randall *et al.* 1981). Other seabirds that have bred in the Eastern Cape are Hartlaub's Gull *Larus hartlaubii,* Grey-headed Gull *L. cirrocephalus* and Damara Tern *St. balaenarum* (Hockey *et al.* 2005).

In this paper, we document recent trends in the numbers of seabirds breeding in the Eastern Cape (excluding breeding by White-breasted Cormorants at inland sites), compare them with trends at seabird colonies farther to the west, and consider factors that may be influencing these trends. In South Africa, Roseate Terns breed only in Algoa Bay and at Dyer Island, Western Cape (Randall & Randall 1980). Therefore, we also report trends in numbers of Roseate Terns breeding at Dyer Island.

METHODS

Counts of numbers of seabirds breeding at localities in the Eastern Cape were obtained from the literature and unpublished observations. Only those counts falling within the main breeding seasons were used, which for Algoa Bay are these: African Penguin, January–September; Cape Gannet, October–January; Cape Cormorant, July–March; White-breasted Cormorant, throughout the year; Kelp Gull, October–January; Roseate Tern, June–September; and Swift Tern, May–July (Randall *et al.* 1981). In the Eastern Cape, Hartlaub's Gull breeds during May–October, mainly May–July (Martin 2001a, 2001b; APM & PAW unpub. rec.); Grey-headed Gull during January–October, mainly April–July (Brooke *et al.* 1999, PAW unpub. rec.); Caspian Tern during February–November (Randall *et*

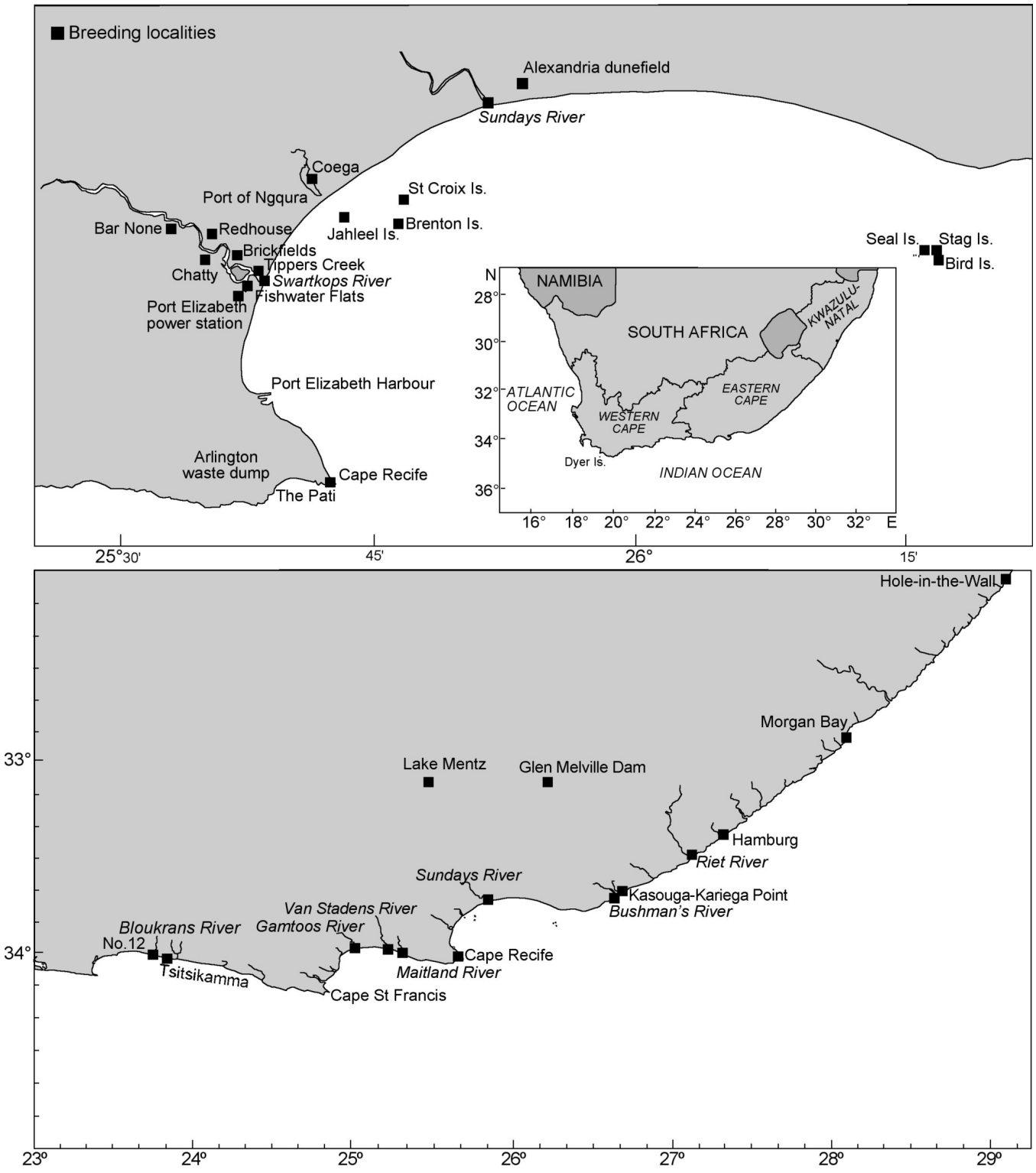

Fig. 1. The main breeding localities of seabirds in South Africa's Eastern Cape (the location of which is shown in the insert in the top panel) and other localities mentioned in the text.

al. 1981, Martin & Randall 1987, Cooper *et al.* 1992); and Damara Tern during November–January (Randall & McLachlan 1982). Although a portion of the Tsitsikamma National Park falls within the Western Cape Province, all birds breeding in this park have been listed under the relevant species accounts.

For African Penguins, counts of numbers of birds in adult plumage that moulted at St. Croix Island were available for 1979/80 and 1980/81 (Randall *et al.* 1986). These numbers were divided by 3.24 to estimate the number of pairs breeding in 1979 and 1980, respectively, using a factor calculated for Robben Island during 1987–1993 (Crawford & Boonstra 1994). Counts of penguins on aerial photographs of St. Croix Island were available for 26 November 1956 (Rand 1963), 25 November 1969 (Shelton *et al.* 1984) and 25 November 1985 (Crawford *et al.* 1990). At St. Croix Island, peaks in the number of penguins moulting occur close to the end of November; the maximum count of penguins on any day at the island was 19 074 on 18 November 1980, which was about 40% of the overall count of

TABLE 1
Estimates of numbers of pairs[a] of African Penguins *Spheniscus demersus* breeding at various localities in the Eastern Cape, 1956–2008

Year	C. Recife	Jahleel I.	Brenton I.	St. Croix I.	Seal I.	Stag I.	Bird I.
1956				5 764	150	40	60
1957–1968							
1969				13 654			
1970–1974							
1975					607		
1976							
1977					102	45	345
1978							
1979				13 821			
1980				14 850			
1981	1	578				23	572
1982–1984							
1985				19 448			
1986			38				
1987–1989							
1990					510	50	3 703
1991						15	3 194
1992					372	24	3 784
1993		549	31	19 478	375	21	2 293
1994							
1995							3 651
1996							
1997		454	35				1 621
1998							
1999		243	20	14 005	316	23	3 883
2000		538	32	15 211	433	24	4 093
2001				16 950	345	24	5 376
2002							
2003		141		9 116			936
2004		479	32	10 088	295	20	2 951
2005		316	36	4 153	319	23	3 203
2006		301	17	8 077	237	13	2 822
2007		141	3	4 363	87	6	1 403
2008		65		7 739		8	2 765

[a] Except for St. Croix Island, figures for 1956 are from Rand (1963). Those for St. Croix Island in 1956, 1969 and 1985 are from counts of penguins on aerial photographs taken in late November, and in 1979 and 1980, they are from counts of penguins in adult plumage that moulted at the island (Randall *et al.* 1986), following the methods described in the text. Other counts up to 1993 are from Crawford *et al.* (1995). Other later counts are unpublished records of the Department of Environmental Affairs and Tourism, South Africa. Blank entries signify an absence of known information.

adult penguins that moulted at the island in 1980/81 (Randall *et al.* 1986). We assumed that the counts on the aerial photographs represent 40% of adult penguins moulting at the island. Hence, counts made on aerial photographs were multiplied by 2.5 and divided by 3.24 to estimate the number of pairs breeding at the island.

Additional counts of numbers of breeding pairs were undertaken. During 1997–2008, several visits were made to islands in Algoa Bay. Breeding pairs of African Penguins were counted as described in Crawford *et al.* (1995). The number of pairs of Cape Gannets breeding at Bird Island was updated from Crawford *et al.* (2007a), using methods reported in that paper. Counts of breeding pairs of cormorants were made as described by Crawford *et al.* (2007b) and of Kelp Gulls, as described by Crawford *et al.* (1982). At mainland localities, numbers of seabirds breeding were counted following methods reported by Martin & Randall (1987). For gulls and terns, nest totals, including unoccupied nests, are reported, but for cormorants, whose nests may persist for some time, only occupied nests were used. The numbers of White-breasted Cormorants nesting at Coega saltpans were monitored by PAW from August 2003 to August 2004 and then again between March and July 2007. The Port Elizabeth area was covered on a monthly basis by PAW between February 2003 and August 2004, and again from March to September 2006, to record numbers of Kelp Gulls present (Whittington *et al.* 2006a). Counts were also made of non-breeding seabirds at the localities visited, and these are reported when pertinent to gauging trends in numbers of seabirds.

The diet of Cape Gannets at Bird Island was examined using methods detailed in Berruti *et al.* (1993). Following Klages *et al.* (1992), samples were collated in split years commencing 1 April and ending 31 March, at the conclusion of breeding. The mean percentage contribution by mass of Sardine *Sardinops sagax* to the diet was determined for each split year. Annual catches of Sardine in the Eastern Cape that were taken east of Cape St. Francis were provided by J.J. van der Westhuizen from records maintained by Marine and Coastal Management, Department of Environmental Affairs and Tourism, South Africa.

RESULTS

African Penguin

In Algoa Bay, African Penguins have nested in largest numbers at St. Croix (fewer than about 20 000 pairs) and Bird (more than 5000 pairs) islands (Table 1). Several hundred pairs have nested at both Jahleel and Seal islands; maximum numbers observed at Brenton and Stag islands have been 38 and 50 pairs respectively. Breeding was attempted at Cape Recife in 1981—three adults and one egg were present (Every 1983)—but apart from this, no mainland breeding by penguins has been recorded in the Eastern Cape.

Aerial photographs of St. Croix Island yielded counts of 7470 penguins on 26 November 1956 (Rand 1963), 17 696 penguins on 25 November 1969 (Shelton *et al.* 1984) and 25 205 on 25 November 1985 (Crawford *et al.* 1990), deemed equivalent to 5764, 13 654 and 19 448 pairs respectively. The value for 1956 agrees with Rand's (1963) estimate of about 12 000 adult birds; the value for 1985 is similar to the count of nests conducted in 1993 (Table 1). During 1979/80, 44 791 adult penguins moulted at the island; in 1980/81 the count was 48 113 (Randall *et al.* 1986). These values are equivalent to some 13 800–14 800 pairs of penguins breeding at the island, which is similar to the estimate for 1969 made from the aerial photograph of that year. Counts of 14 000–17 000 pairs were made during 1999–2001, after which numbers decreased to some 10 000 pairs or fewer (Table 1). The mean of estimates for St. Croix Island for 1969–2001 is 15 927 pairs (n = 8, standard deviation (SD) = 2421), and for 2003–2008, it is 7256 pairs (n = 6, SD = 2465).

It was thought that there were about 500 adult penguins at the Bird Island group (including Seal and Stag islands) in 1956 (Rand 1963). In 1981, 572 nests were counted at Bird Island. This value increased to 3700 pairs in 1990 and to more than 5000 pairs in 2001, but fell to about 2800 pairs in 2008 (Table 1).

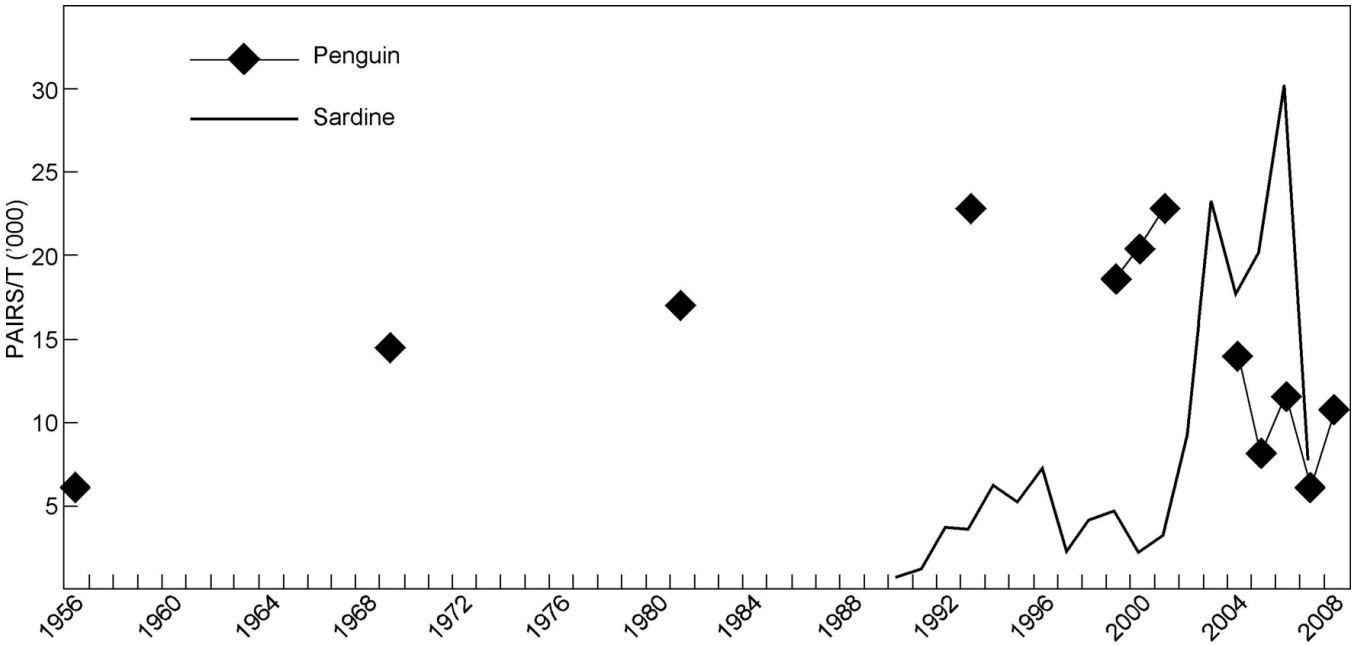

Fig. 2. Trends in numbers of African Penguins *Spheniscus demersus* (000s of pairs) breeding in Algoa Bay and in the directed catch of Sardine *Sardinops sagax* (000s of tonnes) taken by the purse-seine fishery operating in the Eastern Cape Province east of Cape St. Francis, 1956–2008.

The overall population of African Penguins in Algoa Bay may have been about 7000 pairs in 1956, was about 15 000 pairs in the late 1970s, more than 20 000 pairs in 1993 and 2001, and averaged 10 010 pairs during 2004–2008 (n = 5, SD = 3054, Fig. 2).

The annual purse-seine catch of Sardine taken east of Cape St. Francis was minimal before 1990 and remained below 10 000 t until 2002. It then increased sharply, reaching 30 000 t in 2006, before decreasing to 7500 t in 2007 (Fig. 2).

Cape Gannet

In the Eastern Cape, Cape Gannets breed only at Bird Island, where numbers of pairs have been estimated from the area occupied by breeding birds, measured on aerial photographs, and the density of nests (Randall & Ross 1979, Klages *et al.* 1992, Crawford *et al.* 2007a). The numbers breeding increased from about 19 000 pairs in 1956/57 to more than 50 000 pairs by 1986/87 and 98 000 pairs in 2005/06, but decreased to 75 000–80 000 in 2006/07–2007/08 (Fig. 3).

Sardine contributed 10%–60% by mass of the diet of Cape Gannets at Bird Island during 1979/80–2002/03, then 74%–97% over the next four split years before decreasing to 22% in 2007/08 (Fig. 3).

Cape Cormorant

Six pairs of Cape Cormorants bred at Stag Island in November 1946 (Rand 1963). No further counts were reported until 1977 (Randall *et al.* 1981). At Tsitsikamma National Park, 72–75 pairs nested in the early 1980s (Crawford 1983), and 37 in 2003/04 (Whittington 2004).

In 1978/79, 208 nests were counted at St. Croix Island (Randall *et al.* 1981). In 2004/05, 266 nests were counted at three islands; in 2005/06, 216 nests at four islands; and in 2007/08, 384 nests at five islands (Table 2). In the Swartkops Estuary, the Coordinated Waterbird Count (CWAC) of Cape Cormorants was 356 on 14 July 2007, compared with a maximum of 68 during 1983–1985 (Martin & Baird 1987, APM unpub. rec.). Therefore, the population in Algoa Bay appears to have increased since the start of the current century.

White-breasted Cormorant

Only coastal breeding localities of White-breasted Cormorants are considered here. The species also breeds at inland water bodies. For example, five active nests were counted at Glen Melville Dam on 13 March 2008 (RJMC, ABM pers. obs.).

Up to 31 pairs of White-breasted Cormorants have bred in Tsitsikamma National Park, where counts have been sporadic (Table 3). A few pairs have bred at mainland coastal localities east of Algoa Bay, including Hole-in-the-Wall, where the species was present in 1932 or earlier (Brooke *et al.* 1982).

In the Eastern Cape, most coastal breeding by White-breasted Cormorants occurs in Algoa Bay. During 1985–1994, 124–224 pairs bred at Redhouse saltpans in the Swartkops River Estuary (Martin & Randall 1987, APM unpub. rec.). The colony then decreased (Table 3) and became extinct in 2004 after several years of poor breeding attributable to harassment by dogs and human egg thieves (APM pers. obs.). It is possible that the birds relocated to Coega saltpans, where birds bred in 2003–2004 and 2007–2008. In 2007, there were 105 occupied nests, and in 2008, 110 nests, of which five were occupied (APM, PAW unpub. rec.). At Coega saltpans, peaks in the numbers of nests occurred in June 2004 and in March 2007. Peak numbers of adults were recorded in March in both of those years (Fig. 4). In 2007, the peak nest count was 62% more than the highest count recorded in 2004, and the highest count of adult birds present was 49% greater than the corresponding peak in 2004. In 2001, 64 pairs bred at the Sundays River estuary (Tankatara saltpans, 33°42.4′S 25°45.8′E).

At St. Croix Island, 86 pairs or nests were counted in 1958, more than 100 in 1970, 117 in 1999, 89 in 2000 and 143 in 2008. In March 2004, 80 pairs bred at the St. Croix group of islands. The increase after 2004 may have resulted from some birds moving from Redhouse saltpans to St. Croix Island. At the Bird Island group, there were 64 nests in 1979 and 79 nests in 2005, indicating relative stability.

The overall population in Algoa Bay was at least 296 pairs in 1993, 190 pairs in 1999 and 197 pairs in 2008 (Table 3). If the

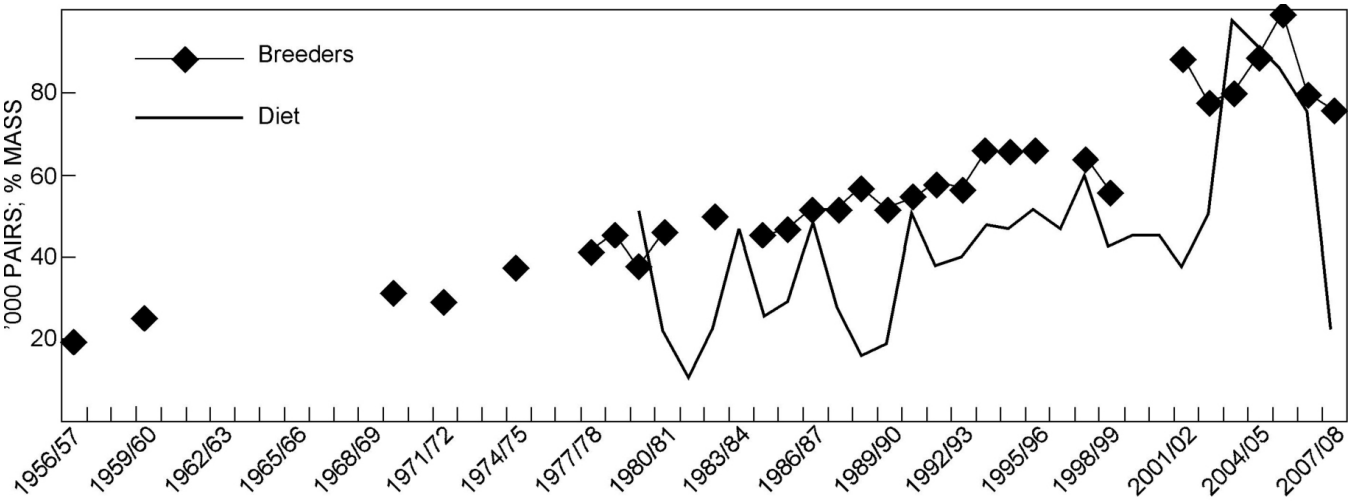

Fig. 3. Trends in numbers of Cape Gannets *Morus capensis* (000s of pairs) breeding in Algoa Bay and in the contribution of Sardine *Sardinops sagax* (% mass) to their diet, 1956/57–2007/08.

105 unoccupied nests at Coega saltpans are included for 2008, the population then would have been 302 pairs, similar to that for 1993.

Kelp Gull

Some 200 pairs of Kelp Gull were recorded breeding at Stag Island in 1945/46 (Rand 1963). Up to 2006, 15 breeding sites were used by Kelp Gulls in the Eastern Cape (Whittington *et al.* 2006b). In February 2006, a pair was found with two large chicks between the Ngculura River mouth and Hamburg, the most easterly breeding site recorded to date (Tree 2006). A new colony of 20 pairs formed at Tippers Creek on the Swartkops River in 2006/07 and had 60 nests in the 2007/08 season (APM, unpub. rec.). There are now five colonies on the Swartkops River and adjacent pans: Bar None saltpans, Chatty saltpans, Redhouse saltpans (Martin & Randall 1987), Brickfields Island and Tippers Creek.

By 2004, two of the 10 colonies documented by Crawford *et al.* (1982)—St. Croix Island, Riet River—had been abandoned, and five previously undocumented colonies had formed or been discovered (Whittington *et al.* 2006b). Colony sizes ranged from just a single pair at Kasouga-Kariega Point and near Hamburg to more than 500 pairs at the Swartkops River, where 679 pairs in total were recorded breeding in 2003/04. Some mainland sites in the Eastern Cape showed large increases between 1982/83 and 2004/05, but the breeding population on the Algoa Bay islands declined by 89% during this period (Table 4, Whittington *et al.* 2006b). Overall, the population in the Eastern Cape declined by 15% between 1977/78–1980/81 and 2004/05. However, if the colonies on the Indian Ocean coast of the Western Cape are included the breeding population of the region showed a 71% increase during this period (Whittington *et al.* 2006b).

Hartlaub's Gull

An immature of this species was first reported from Port Elizabeth in November 1977 (Nicholls 1977), and a confirmed sighting of an adult bird was made at Cape Recife in October 1987 (Martin 1988). Single birds were feeding young at Chatty saltpans on the Swartkops River's floodplain in 2000 and 2001, and there were at least two birds breeding in 2002. In those years, seven, 16 and six adults were present respectively (Martin 2001a, 2001b, 2002). In July 2007, a mixed Hartlaub's × Grey-headed Gull pair was seen with a fledged chick at the Swartkops Estuary, and a female was observed copulating with a Grey-headed Gull at the Chatty saltpans (PAW unpub. rec.). Between May and July 2007, one pair and a mixed Hartlaub's Gull × Grey-headed Gull pair bred at Coega saltpans (PAW unpub. rec.). On 19 May 2008, 20 adults and 28 hybrid Grey-headed × Hartlaub's Gulls were seen with 308 Grey-headed Gulls at a breeding colony at Coega saltpans (APM unpub. rec.).

Non-breeding birds were observed at two more localities. At Fishwater Flats Water Reclamation Works, numbers peaked during the summer months, with 44 being recorded in December 2003. At Arlington waste dump, most birds were recorded during the autumnal and winter months, peaking at nine in June 2007 (PAW unpub. rec.). Although the Eastern Cape population of Hartlaub's Gulls is increasing, extensive cross-breeding with Grey-headed Gulls may have slowed this increase.

Grey-headed Gull

The Grey-headed Gull was present in the Port Elizabeth area in 1951 (Anonymous 1951), but it was considered to be uncommon (Skead 1967). Although the first recorded breeding attempts do not appear to

TABLE 2
Counts[a] of breeding pairs of Cape Cormorants *Phalacrocorax capensis* in the Eastern Cape, 1977/78–2007/08

Season	Tsitsikamma	Jahleel I.	Brenton I.	St Croix I.	Seal I.	Stag I.
1977/78					44	
1978/79				208		
1979/80						
1980/81	75		80			
1981/82	72					
1982/83–1995/96						
1996/97		40	0	93		
1997/98		14	0	0		
1998/99–1999/00						
2000/01		14	0	0	0	0
2001/02–2002/03						
2003/04	37					
2004/05		22		238		6
2005/06		18	26	126	46	0
2006/07				157		
2007/08		4	26	296	58	0

[a] Estimates for 1977/78–1981/82 are from Cooper *et al.* (1982), except for Tsitsikamma (Crawford 1983). Information for Tsitsikamma in 2003/04 is from Whittington (2004) and, for other localities in 2004/05, from PAW (unpub. rec.). Other counts are unpublished records of the Department of Environmental Affairs and Tourism, South Africa. Birds breeding in the Western Cape section of the Tsitsikamma National Park have been included in the entries for that locality. Blank entries signify an absence of known information.

have been documented, birds were reported to be nesting at Fishwater Flats on the Swartkops Estuary in 1979 (Hosten 1981), and a breeding colony became established at Redhouse saltpans by 1982, when there were 28 pairs (Martin & Randall 1987). Breeding took place at this site in 12 of the 17 years between 1982 and 1998, with a maximum of 95 pairs in 1990 (APM unpub. rec., Table 5). This colony of Grey-headed Gulls was recorded breeding at three other localities on the Swartkops floodplain: a pan at the Port Elizabeth Power Station in 2001 (McInnes 2006); Chatty saltpans in 1988, 1990, 1999–2005 and 2007, with up to 153 pairs (APM, PAW unpub. rec.); and Bar None saltpans in 1993, 2000 and 2004–2007. In 2006, 608 pairs bred at Bar None saltpans (APM unpub. rec.). Other breeding sites were at Coega saltpans in 1996, 1998, 2007 (PAW unpub. rec.) and 2008, when there were 456 nests (APM unpub. rec.), and Sundays River in 2000 and 2001 (APM unpub. rec.). A solitary nest was recorded at the inland locality of Lake Mentz in 1992 (Brooke *et al.* 1999).

Flocks of more than 100 non-breeding birds were recorded at a further six localities within the Port Elizabeth area, the highest numbers being 450 on the Swartkops Estuary in February 2007 and 450 at Arlington waste dump in May 2007 (PAW unpub. rec.). In the Swartkops Estuary, the CWAC count of Grey-headed Gulls was 280 on 17 January 2007, compared with a maximum of 36 during 1983–1985 (Martin & Baird 1987, APM unpub. rec.). On 26 July 2006, 13 adults in breeding plumage and an immature bird were recorded at Bird Island (AJT, PAW pers. obs.). Randall *et al.* (1981) considered this species to be a rare vagrant to the Algoa Bay islands, the only record at Bird Island being of a bird flying over.

Caspian Tern

A minimum of two pairs of Caspian Terns bred at Bird Island in September 1924 and 35–50 pairs at Stag Island in November 1936 (Cooper *et al.* 1992). Breeding was again observed at Stag Island in 1945 [50 pairs (Rand 1963)] and 1977 (two pairs) and in 1979 at nearby Seal Island [one pair (Randall *et al.* 1981)]. However, there are no further records of breeding at islands in Algoa Bay.

In 1982, breeding was observed at Redhouse saltpans in the Swartkops Estuary, where the colony grew from nine pairs in 1982 to 58 pairs in 1987. The number of pairs breeding at this locality has subsequently fluctuated from 0 to 50 pairs, becoming erratic in the 21st century (Table 6). Sometimes one to two pairs have bred on the Chatty or Bar None saltpans (APM pers. obs.). Up to four had been observed at the Swartkops River out of the breeding season by 1981 (Randall *et al.* 1981).

Breeding was recorded at Coega saltpans in 2007. On 23 March, 40 adults were present at this locality, and on 25 May, 30 were present when two chicks and 11 sitting birds (taken to represent 12 nests) were recorded. On 22 June, 16 adults and 11 fledged chicks were seen there. On 24 July, one nest remained with a downy chick and an egg (PAW unpub. rec.).

Roseate Tern

The history of Roseate Terns in South Africa has been reviewed by Tree (2005). In the Eastern Cape Province, they were breeding at the Bird Island group of islands (including Seal and Stag islands) in 1937 (Courtenay-Latimer 1937). Some 30–55 pairs attempted to breed at Cape Recife in 1967–1968, 70 pairs at Bird Island in 1971 and more than 100 pairs at St. Croix Island in 1977 (Every 1975, Randall *et al.* 1991, Tree 2005). Numbers breeding in the Eastern Cape peaked at 240–250 pairs in 2000 and 2001, and 211 pairs were present in 2007 (Table 7).

At Dyer Island (Western Cape), a few pairs bred in 1909, 1913, 1919, 1929, 1930 (two pairs), 1971 (six nests) and sometime during 1972–1975 (Randall & Randall 1980), but none thereafter until 1996, apart from one pair in 1991. Numbers have since fluctuated between three and 18 pairs (Table 7).

Swift Tern

Three pairs of Swift Terns bred at Stag Island in 1924 (Cooper *et al.* 1990). About 200–225 individuals, taken to represent 100–125 pairs, bred at the island in 1978 (Randall *et al.* 1981), and about 100 pairs in 1984 (Cooper *et al.* 1990). A similar number bred at the Bird Island group in 1992, but this increased to about 660 pairs in 2000 and 2001 (Table 8). In 2008, 729 pairs bred at the Coega saltpans, the first recorded breeding on the Eastern Cape mainland (APM unpub. rec.), confirming a large increase in the Eastern Cape's population since the late 1970s.

Damara Tern

Damara Terns were first recorded in the Eastern Cape at the Sundays River mouth in January 1979, when a juvenile bird was seen being fed by two adults (Every 1979, Underhill *et al.* 1980). This record represented an eastward extension of about 550 km in the distribution of this species. It may have been overlooked earlier.

At Cape Recife, one pair of Damara Terns may have nested in 1999/2000, because adults were feeding a juvenile on 5 January 2000 after sightings of adults at the locality in September and December 1999 (Tree 2000b). A nest was found at Cape Recife on 14 December 2001, and the chick from this nest and three recently fledged juveniles were seen on 5 January 2002 (Martin & Taylor 2002). On 15 October 2003, a calling adult carrying a fish was seen flying around the dunes behind The Pati beach on the west side of Cape Recife. It seemed to lose the fish and then went back out to sea, but it may have been feeding a chick. Two adults in breeding plumage, in a party of 13 birds at Cape Recife Point on 28 September 2006, were observed courtship feeding (PAW unpub. rec.). Damara Terns were first found wintering at Cape Recife in 1999 (Tree 2000a) and have done so subsequently (e.g. Tree 2002). In recent years, the number of winter records at the locality have increased (PAW unpub. rec.). Although the origin of these birds has yet to be ascertained, it is assumed to be local.

At the mouth of the Swartkops River, an adult was seen with a juvenile on 16 December 2003, and a pair with a flying juvenile, on 28 January 2007 (PAW unpub. rec.). At Coega sand dunes, there was a chick and a separate pair of adults mobbing on 13 December 1990 and 1 December 1999, and three chicks and another two separate pairs of adults mobbing on 30 November 2007 (APM unpub. rec.).

Randall & McLachlan (1982) found 14 pairs of birds, 12 of which had eggs or chicks, and a single adult in the dune field east of the Sundays River in November and December 1980. Watson and Kerley (1995) found 12 pairs and two individuals between the Sundays River mouth and a point 25 km further to the east in the Alexandria dune field. Watson (1995) estimated the population in the Alexandria dune field to number 15–20 pairs between 1991

TABLE 3
Counts[a] of breeding pairs of White-breasted Cormorants *Phalacrocorax lucidus* at coastal localities in the Eastern Cape, 1956–2008

Year	Tsitsikamma	Redhouse saltpans	Coega saltworks	Jahleel I.	Brenton I.	St Croix I.	Sundays R.	Seal I.	Stag I.	Morgan Bay	Hole-in-the-Wall
1956									4		
1957									22		
1958						86					
1959–1966											
1967						2					
1968–1969											
1970						>100					
1971	7					2					
1972–1974											
1975	10										
1976											
1977								24			
1978	30										
1979				30				59	5		
1980	31					46				15	3
1981	23										
1982											
1983											
1984		36									
1985		152									
1986		174									
1987		141									
1988		124									
1989		163									
1990		138									
1991		164									
1992		174				3		18	1		
1993		224		0	0	60			12		
1994		174									
1995		20									
1996		50		0	0	21					
1997		94		0	0	4					
1998		49				30					
1999		43		0	0	117		30			
2000		52		0	0	89	5				
2001		10					64				
2002		5					7				
2003	15	8	7	0		10		12			
2004		0	65	11	8	61		22	5		
2005		0		8	0	19		77	2		
2006		0		0	0	21		58			
2007		0	105	0	0	23		23	17		
2008		0	5	0	0	143			49		

[a] Estimates for Redhouse saltpans are from Martin & Randall (1987) and APM (unpub. rec.); for Coega saltpans (where there were 110 nests in total on 19 February 2008, although only five were occupied) and Sundays River from APM and PAW (unpub. rec.); for other localities 1956–1981 from Brooke *et al.* (1982), except for Tsitsikamma (Crawford 1983) and Hole-in-the-Wall (du Toit *et al.* 2003). Information for Tsitsikamma in 2003 is from Whittington (2004) and, for Seal Island in 2003 and Jahleel, Brenton and St. Croix islands in 2004, from PAW (unpub. rec.). Other counts are unpublished records of the Department of Environmental Affairs and Tourism, South Africa. The record of White-breasted Cormorants breeding at Bird Island on 12 August 1997 (du Toit *et al.* 2003) has been discounted, because the original source was not indicated, the species did not breed at this island before 1981 (Randall *et al.* 1981) or on numerous subsequent visits, and no nests were present on 13 August 1997 (RJMC pers. obs.). Birds breeding in the Western Cape section of the Tsitsikamma National Park have been included in the entries for that locality.

and 1994. In December 2005, 22 birds were located in the same area that was surveyed by Watson and Kerley (1995), including one incubating bird and a flying juvenile (Whittington & Klages 2006). The number of Damara Terns recorded during the 2005/06 survey was similar to that found by Watson & Kerley (1995), and the population in the Alexandria dune field was thought to be stable (Whittington & Klages 2006).

DISCUSSION

African Penguins and Cape Gannets breed only in Namibia and South Africa, feeding mainly on Sardine and Anchovy *Engraulis encrasicolus* (references in Hockey *et al.* 2005). Cape Gannets may also feed substantially on hake *Merluccius* spp. discarded by fishing boats and on Saury *Scomberesox saurus* (e.g. Berruti *et al.* 1993). In Namibia, the populations of penguins and gannets decreased by more than 85% after the 1960s, following the collapse of the Namibian Sardine population (Crawford 2007). The proportions of both Cape Gannets and the epipelagic fish on which they feed that were distributed off South Africa increased after the mid-1970s, as they decreased off Namibia (Crawford *et al.* 2007a). A recent eastward shift of Sardine off South Africa (Fairweather *et al.* 2006) led to decreases in populations of penguins and gannets in the Western Cape Province (Crawford *et al.* 2008c).

In the Eastern Cape Province, numbers of penguins and gannets increased in the latter half of the 20th century. However, after 2001, numbers of penguins halved, whereas those of gannets increased markedly. The eastward displacement of Sardine appears to have resulted in this food source becoming increasingly available to gannets breeding at Bird Island in the Eastern Cape. From 2003/04, its contribution to their diet increased (Crawford *et al.* 2007a). When breeding, Cape Gannets have a much greater foraging range than do African Penguins. They are able to feed 250 km from colonies (Grémillet *et al.* 2004), compared with some 40 km or less for African Penguins (Heath & Randall 1989, Petersen *et al.* 2005), which enabled them to benefit from the eastward displacement of Sardine before the penguins did. A recent collapse of Sardine off South Africa will preclude an increased availability of this species in Algoa Bay during the next several years. Off South Africa, the biomass of spawning Sardine fell from 4.1 million tonnes in 2002 to 0.3 million tonnes in 2007 (Twatwa *et al.* 2007), and the contribution of Sardine to the diet of gannets at Bird Island decreased in 2007/08.

The eastward shift of Sardine cannot explain the recent decrease of penguins in the Eastern Cape; rather, it might have been expected that penguins would have increased had Sardine become more available in the vicinity of their breeding colonies. The commercial catch of Sardine taken east of Cape St. Francis increased substantially after 2001, before decreasing in 2007. Two possible explanations exist for the decrease in the numbers of penguins breeding in the Eastern Cape in the early part of the 21st century. First, the high catches of Sardine harvested in the Port Elizabeth vicinity may have reduced the availability of Sardine to penguins, either by reducing their density or by breaking up shoals of fish. Trends in African Penguins have been influenced by the availability of food (e.g. Crawford 1998, Crawford *et al.* 2001). They may hunt cooperatively, swimming rapidly round a school of fish to compress it (Wilson 1985, Wilson & Wilson 1990). Second, construction of the harbour (Port of Ngqura) at Coega, 7.5 km west of St. Croix Island, the main colony of penguins in the Eastern Cape, commenced in 2002 and was completed in 2005. The construction included considerable dredging (Anonymous 2004), which may have increased the load of sediment in adjacent waters, thereby hampering the feeding of penguins.

Two other seabirds in southern Africa also feed substantially on Sardine, Swift Tern and Cape Cormorant (references in Hockey *et al.* 2005). There was a large increase in numbers of Swift Terns breeding in the Eastern Cape in 2000, and numbers of Cape Cormorants also increased recently. Like the African Penguin and Cape Gannet, the Cape Cormorant breeds only in Namibia and South Africa, the bulk of its population occurring in waters of the Atlantic Ocean west of Cape Agulhas. It also has suffered a large decrease in Namibia (Crawford *et al.* 2007b).

There have been recent eastward extensions in the ranges of some southern African seabirds, including Hartlaub's Gull (Fig. 5) and Damara Tern; the first records in the Eastern Cape were in 1977 and 1979 respectively. Both species have their main populations in the Benguela system off western southern Africa (Hockey *et al.* 2005), but they now breed in the Port Elizabeth vicinity. In 2003, Crowned Cormorants were observed breeding at No. 12 stack in Tsitsikamma

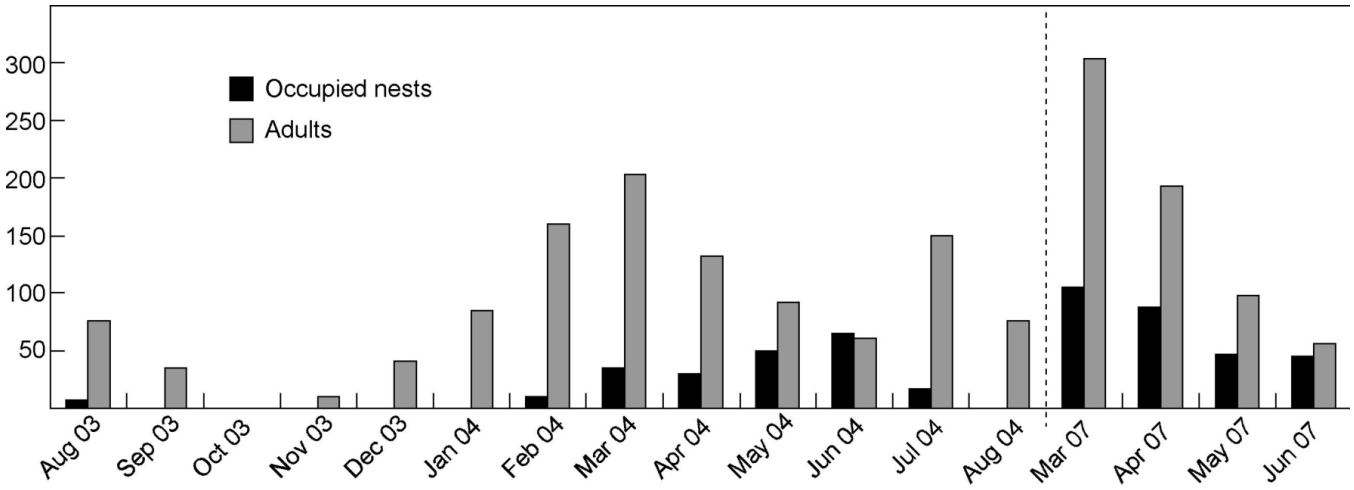

Fig. 4. Trends for White-breasted Cormorants *Phalacrocorax lucidus* in numbers of occupied nests and adults at Coega saltpans, August 2003–August 2004 and March–June 2007 (PAW unpub. rec.).

TABLE 4
Counts[a] of breeding pairs of Kelp Gulls *Larus dominicanus* in the Eastern Cape, 1945/46–2007/08

Season	Tsitsikamma	Gamtoos R.	Maitland R,	Swartkops R.	Coega saltworks	Jahleel I.	St Croix I.	Seal I.	Stag I.	Bird I.	Kasouga-Kariega Pt.	Riet R.	Hamburg
1945/46									200				
1977/78						100	410	390	*c.* 50				
1978/79		25		102									
1979/80			32									2	
1980/81	65									20			
1981/82	51												
1982/83				262									
1983/84				354									
1984/85				459									
1985/86				505									
1986/87				505									
1987/88				440									
1988/89				409									
1989/90				443									
1990/91				347									
1991/92				481									
1992/93				499									
1993/94				454									
1994/95				467									
1995/96				448									
1996/97				560									
1997/98				367									
1998/99				432									
1999/00				494					5				
2000/01		71		416									
2001/02				382									
2002/03				621									
2003/04	19	139	2	683	30				27			0	
2004/05				601		12	0	47		23	1		
2005/06				577		10	1	138	46	43			1
2006/07				610									
2007/08			4	674	97								

[a] Estimates for 1945/46 are from Rand (1963); for 1977/78–1981/82, from Crawford *et al.* (1982); and for 2003/04–2004/05, from Whittington *et al.* (2006b). Estimates for Gamtoos River in 2000/01 are from Tree (2001). Remaining estimates for van Stadens River (Maitland River not counted in 2007/08), Swartkops River (combining counts at Bar None saltpans, Chatty saltpans, Redhouse saltpans, Brickfields Island and Tippers Creek) and Coega saltpans are from Martin & Randall (1987) and APM (unpub. rec.). Other counts are unpublished records of the Department of Environmental Affairs and Tourism, South Africa. Birds breeding in the Western Cape section of the Tsitsikamma National Park have been included in the entries for this locality. Records of breeding of five pairs at Brenton Island on 30 May 2000 and five pairs at Stag Island on 31 May 2000 (du Toit *et al.* 2003) have been discounted because the original source was not indicated and the dates do not conform to the known breeding season of the species.

TABLE 5
Counts[a] of breeding pairs of Grey-headed Gulls *Larus cirrocephalus* in the Eastern Cape, 1979–2008

Year	Port Elizabeth power station	Chatty saltpans	Bar None saltpans	Redhouse saltpans	Fishwater Flats	Coega saltworks	Sundays R.	Lake Mentz
1979					Bred			
1980-1981								
1982				28				
1983		0	0	2				
1984		0	0	0				
1985		0	0	3				
1986		0	0	7				
1987		0	0	0				
1988		64	0	69				
1989		0	0	0				
1990		0	0	95				
1991		0	0	2				
1992		0	0	14				1
1993		0	82	38				
1994		0	0	0				
1995		0	0	0				
1996		0	0	6		31		
1997		0	0	28				
1998		0	0	59		15		
1999		Bred	0	0				
2000		40	50	0			2	
2001	Bred	>25	0	0			3	
2002		63	0	0				
2003		98	0	0				
2004		>69	15	0				
2005		153	47	0				
2006		0	608	0				
2007		30	6	0		202		
2008				0		456		

[a] Information for 1979 is from Hosten (1981); for Swartkops floodplain sites 1982–2007 and Sundays River, from Martin & Randall (1987) and APM (unpub. rec.); for other localities 1988–1998, from Brooke *et al.* (1999); for 2000–2001, from McInnes (2006); and for 2003–2007, from PAW (unpub. rec.). A record of 95 pairs breeding at Redhouse saltpans in 1990 was incorrectly attributed to Chatty saltpans by Brooke *et al.* (1999) and is revised here. Blank entries signify an absence of known information.

TABLE 6
Counts[a] of breeding pairs of Caspian Terns *Hydroprogne caspia* in the Eastern Cape, 1945–2008

Year	Redhouse saltpans	Coega saltworks	Stag I.	Seal I.
1945			50	
1946–1976				
1977			2	
1978				
1979				1
1980–1981				
1982	9			
1983	25			
1984	7			
1985	33			
1986	35			
1987	58			
1988	41			
1989	38			
1990	41			
1991	46			
1992	20			
1993	7			
1994	50			
1995	0			
1996	40			
1997	24			
1998	13			
1999	23			
2000	21			
2001	1			
2002	28			
2003	0			
2004	4			
2005	47			
2006	1			
2007	0	12		
2008	18	1		

[a] Information for 1945 is from Rand (1963). Estimates for Redhouse saltpans are from Martin & Randall (1987), Cooper *et al.* (1992) and APM (unpub. rec.); for Coega saltworks, from PAW (unpub. rec.); and for Seal and Stag islands, from Randall *et al.* (1981). Sometimes one to two pairs have bred on the Chatty or Bar None saltpans (APM pers. obs.). Blank entries indicate an absence of known information.

National Park, just west of the Eastern Cape, extending to the east the known distribution of the species by 169 km and its breeding range by 355 km (Whittington 2004). The eastern range of the species was extended a further 230 km by the sighting of a bird at Bushman's River, Kenton-on-Sea, the first record for the Eastern Cape, in July 2006 (Fig. 5). Another Crowned Cormorant was seen at Bird Island in Algoa Bay in March 2008 (Crawford *et al.* 2008d). Numbers of Bank Cormorants *P. neglectus* breeding in the north of the Western Cape have decreased, but some colonies in the south of that province have increased (Crawford *et al.* 2008a). Numbers of Kelp Gulls breeding in the south of the Western Cape and in the Indian Ocean sector of South Africa have recently increased, but numbers breeding in the north of the Western Cape have decreased (Whittington *et al.* 2006b, Crawford *et al.* 2008d).

These movements to the south and east or increases in populations in the east, and those of Cape Gannets, conform with similar changes in the distribution of other South African marine resources, including the commercially-exploited Anchovy, Sardine and Rock Lobster *Jasus lalandii* (Fairweather *et al.* 2006, Roy *et al.* 2007, Cockroft *et al.* 2008) and suggest some influence of large-scale environmental change. In the north of the Western Cape, increased frequencies of lobster walkouts (when large numbers of lobsters walk out of the ocean onto the beach) have been associated with the occurrence of low levels of oxygen in seabed water (Cockroft *et al.* 2008). A shift to the east in the spawning of Anchovy coincided with reduced sea surface temperatures in coastal waters east of Cape Agulhas (Roy *et al.* 2007). The increases of Kelp Gulls in the east of South Africa may also have been influenced by urban growth and fishing, augmenting food availability via rubbish tips and discarded catches (Whittington *et al.* 2006b).

In southern Africa, White-breasted Cormorants, Grey-headed Gulls and Caspian Terns all breed at inland localities as well as on the coast. The population of White-breasted Cormorants in the Eastern Cape is probably stable, despite disturbances by dogs and humans on the Swartkops River floodplain, because alternative suitable breeding habitat has been available at offshore islands and in the Coega saltpans. Numbers of Caspian Terns breeding in the Eastern Cape have fluctuated below 60 pairs, becoming erratic since 2000. There has been a recent large increase in the numbers of Grey-headed Gulls in the Eastern Cape, and the species has also increased in Gauteng (McInnes 2006).

Numbers of Roseate and Swift Terns breeding in South Africa increased in the late 1990s (Tree 2005, Crawford *et al.* 2008c). In South Africa, the Roseate Tern is at the western extent of its breeding distribution in the Indian Ocean. Apart from the colony at Dyer Island, it is not known to breed in the southeast Atlantic Ocean, although it also breeds in the North Atlantic and western Pacific Oceans. Swift Terns breed in the Indian Ocean to the east of South Africa and in Namibia. The increases of these two terns in the Eastern Cape, and that of the Grey-headed Gull, for which most of southern Africa's population occurs to the north and east (Brooke *et al.* 1999), suggest the possibility of a build-up in the south of species having eastern affinities.

The large changes in distributions and populations of seabirds in the Eastern Cape have not occurred in isolation. Climate change is thought to be influencing populations of seabirds at the Prince Edward Islands in the southwest Indian Ocean (Crawford *et al.* 2006, 2008b). Off Western Australia, tropical seabirds are

TABLE 7
Estimates of numbers of breeding pairs[a] of Roseate Terns *Sterna dougallii* in South Africa, 1967–2007

Year	Dyer I.	C. Recife	Jahleel I.	St Croix I.	Seal I.	Stag I.	Bird I.	Eastern Cape
1967		39 Eggs						*c.* 30
1968		71 Eggs						*c.* 55
1969–1970								
1971	6							70
1972–1975	Bred							
1976	0							
1977	0			118–139				118–139
1978	0		0	0			Bred	
1979			0	Bred			Bred	
1980				S breed			Bred	
1981			0	0			S breed	
1982			0	Bred			Bred	
1983	0		S breed	Bred			Bred	
1984			0	0			Bred	
1985				Bred			Bred	
1986	0		0	4	0	0	130	134
1987	0							
1988	0							
1989	0							
1990	0							
1991	1							
1992	0			9			112	121
1993	0		0		0	0		
1994	0		0		0	0		
1995	0		0		0	0		
1996	10		0	0	0	0	152	152
1997	5		0	44	0	0	178	222
1998	3		0		0	0	180	180
1999	11		0		0	0	210–220	210–220
2000	6		0		0	0	240–250	240–250
2001	18		0		0	0	240–250	240–250
2002	17		0		0	0		
2003	16		0	30	0	0	70–75	100–105
2004	7		0	30	0	0	70–75	100–105
2005	16		0	58	0	0	75	133
2006	12		0	0	0	0	170	170
2007				58			153	211

[a] Information for Dyer Island for 1971–1978 is from Randall & Randall (1980); and for 2002–2004, from Tree (2005). Birds bred at Dyer Island at some stage from 1972–1975 (Randall & Randall 1980). Information for Cape Recife is from Every (1975), with a mean clutch of 1.28 (Hockey *et al.* 2005) used to estimate the number of pairs breeding. Estimates for islands in Algoa Bay for 1977–1986 are from Randall *et al.* (1991) and for 1971, 1996, 1998–2001 and 2003–2004, from Tree (2005). Other counts are unpublished records of the Department of Environmental Affairs and Tourism, South Africa. Blank entries indicate an absence of known information.
S breed = suspected breeding.

extending their ranges southwards (Dunlop & Wooler 1986), possibly as a result of climate change (Chambers *et al.* 2005). There have been recent changes in the ranges of seabirds in the Pacific Ocean (e.g. Ainley & Divoky 2001).

The altered distributions of seabirds and their prey have conservation implications. For example, they may create a mismatch between the distributions of the breeding localities and the prey of seabirds, as has happened with the African Penguin (Crawford *et al.* 2008c). In the case of the Cape Gannet, which has been able to exploit Sardine as it has moved east, 68% of the world population is now located at Bird Island in the Eastern Cape (Crawford *et al.* 2007a), where recent harbour developments will increase the risk of oil spills. Effective conservation will require both mitigation of the adverse impacts of climate change (e.g. Crawford *et al.* 2008c) and management of undesirable anthropogenic influences (e.g. Whittington *et al.* 2006b).

ACKNOWLEDGEMENTS

We thank our research institutes (listed under addresses), the National Research Foundation through its SEACHANGE programme and NORSA (the Norway–South Africa fisheries cooperation agreement) for supporting this research. PAW acknowledges financial support from the National Research Foundation. CapeNature, Department of Environmental Affairs and Tourism, and South African National Parks provided logistics support. We thank all who have contributed counts or other information to the paper, including B.M. Dyer and L. Upfold, and C. Boucher for the artwork. We are grateful to the organizers of the Indian Ocean Seabird Conference in 2008, where part of this material was presented.

TABLE 8
Estimates of numbers of breeding pairs[a] of Swift Terns *Thalasseus bergii* in the Eastern Cape, 1977–2008

Year	Coega saltpans	Seal I.	Stag I.	Bird I.
1977			Bred	
1978			100–125	
1979			Bred	
1980–1983				
1984			*c.* 100	
1985–1991				
1992		101		
1993–1998				
1999		222		
2000		668		
2001		660		
2002–2005				
2006				47
2007				
2008	729			

[a] Information for 1977–1979 is from Randall *et al.* (1981); for 1984, from Cooper *at al.* (1990); for 1992–2006, from unpublished records of the Department of Environmental Affairs and Tourism, South Africa; and for 2008, from APM (unpub. rec.). Blank entries signify an absence of known information.

REFERENCES

AINLEY, D.G. & DIVOKY, G.J. 2001. Seabird responses to climate change. In: Steel, J.H., Thorpe, S.A. & Turekian, K.K. (Eds). The Encyclopedia of Ocean Sciences. Volume 5. San Diego, California: Academic Press. pp. 2669–2677.

ANONYMOUS. 1951. Records from E.C.W.B.S. members. *The Bee-eater* 2(3): 9.

ANONYMOUS. 2004. Port of Ngqura takes shape. *Southern African Shipping News* 59(3): 12–14.

BERRUTI, A., UNDERHILL, L.G., SHELTON, P.A., MOLONEY, C. & CRAWFORD, R.J.M. 1993. Seasonal and interannual variation in the diet of two colonies of the Cape Gannet *Morus capensis* between 1977/1978 and 1989. *Colonial Waterbirds* 16: 158–175.

BROOKE, R.K., COOPER, J., SHELTON, P.A. & CRAWFORD, R.J.M. 1982. Taxonomy, distribution, population size, breeding and conservation of the Whitebreasted Cormorant, *Phalacrocorax carbo,* on the southern African coast. *Le Gerfaut* 72: 189–220.

BROOKE, R.K., ALLAN, D.G., COOPER, J., CYRUS, D.P., DEAN, W.R.J., DYER, B.M., MARTIN, A.P. & TAYLOR, R.H. 1999. Breeding distribution, population size and conservation of the Greyheaded Gull *Larus cirrocephalus* in Southern Africa. *Ostrich* 70: 157–163.

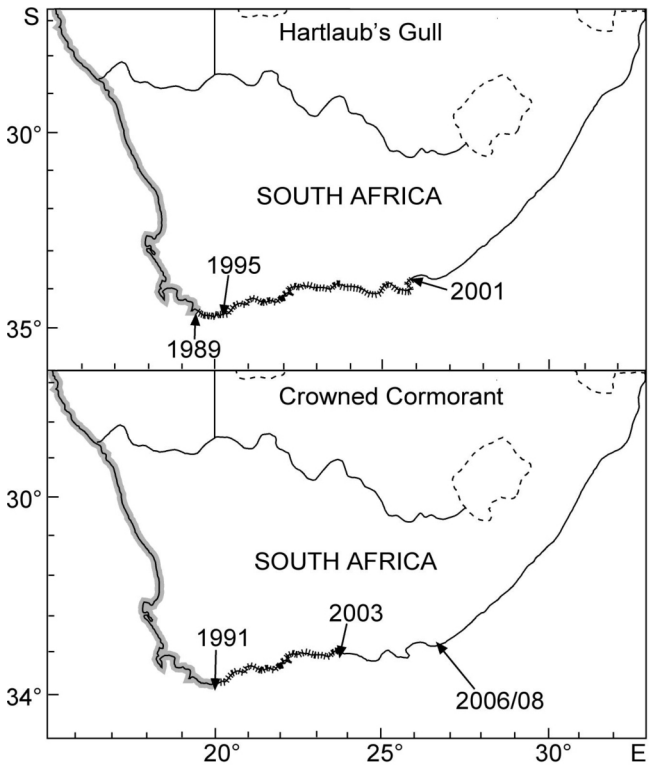

Fig. 5. Recent eastward extensions of the breeding (stippled) and distributional ranges of Hartlaub's Gull *Larus hartlaubii* (upper panel) and Crowned Cormorant *Phalacrocorax coronatus* (lower panel).

CHAMBERS, L.E., HUGHES, L. & WESTON, M.A. 2005. Climate change and its impact on Australia's avifauna. *Emu* 105: 1–20.

COCKROFT, A.C., VAN ZYL, D. & HUTCHINGS, L. 2008. Large-scale changes in the spatial distribution of South African west coast Rock Lobster: an overview. *African Journal of Marine Science* 30: 149–159.

COOPER, J., BROOKE, R.K., SHELTON, P.A. & CRAWFORD, R.J.M. 1982. Distribution, population size and conservation of the Cape Cormorant *Phalacrocorax capensis*. *Fisheries Bulletin South Africa* 16: 121–143.

COOPER, J., CRAWFORD, R.J.M., SUTER, W. & WILLIAMS, A.J. 1990. Distribution, population size and conservation of the Swift Tern *Sterna bergii* in southern Africa. *Ostrich* 61: 56–65.

COOPER, J., BROOKE, R.K., CYRUS, D.P., MARTIN, A.P., TAYLOR, R.H. & WILLIAMS, A.J. 1992. Distribution, population size and conservation of the Caspian Tern *Sterna caspia* in southern Africa. *Ostrich* 63: 58–67.

COURTENAY-LATIMER, M. 1937. Tern observations at Bird Island, Algoa Bay, CP. *Ostrich* 8: 61–67.

CRAWFORD, R.J.M. 1983. Some observations on seabirds breeding in the Tsitsikamma Coastal National Park. *Koedoe* 26: 145–152.

CRAWFORD, R.J.M. 1998. Responses of African Penguins to regime changes of sardine and anchovy in the Benguela system. *South African Journal of Marine Science* 19: 355–364.

CRAWFORD, R.J.M. 2007. Food, fishing and seabirds in the Benguela upwelling system. *Journal of Ornithology* 148 (Suppl 2): S253–S260.

CRAWFORD, R.J.M. & BOONSTRA, H.G.V.D. 1994. Counts of moulting and breeding Jackass Penguins *Spheniscus demersus*: a comparison at Robben Island, 1988–1993. *Marine Ornithology* 22: 213–219.

CRAWFORD, R.J.M., COOPER, J. & SHELTON, P.A. 1982. Distribution, population size, breeding and conservation of the Kelp Gull in southern Africa. *Ostrich* 53: 164–177.

CRAWFORD, R.J.M., WILLIAMS, A.J., RANDALL, R.M., RANDALL, B.M., BERRUTI, A. & ROSS, G.J.B. 1990. Recent population trends of Jackass Penguins *Spheniscus demersus* off southern Africa. *Biological Conservation* 52: 229–243.

CRAWFORD, R.J.M., WILLIAMS, A.J., HOFMEYER, J.H., KLAGES, N.T.W., RANDALL, R.M., COOPER, J., DYER, B.M. & CHESSELET, Y. 1995. Trends of African Penguin *Spheniscus demersus* populations in the 20th century. *South African Journal of Marine Science* 16: 101–118.

CRAWFORD, R.J.M., DAVID, J.H.M., SHANNON, L.J., KEMPER, J., KLAGES, N.T.W., ROUX, J.P., UNDERHILL, L.G., WARD, V.L., WILLIAMS, A.J. & WOLFAARDT, A.C. 2001. African Penguins as predators and prey—coping (or not) with change. *South African Journal of Marine Science* 23: 435–447.

CRAWFORD, R.J.M., DYER, B.M., COOPER, J. & UNDERHILL, L.G. 2006. Breeding numbers and success of *Eudyptes* penguins at Marion Island, and the influence of mass and time of arrival of adults. *CCAMLR Science* 13: 175–190.

CRAWFORD, R.J.M., DUNDEE, B.L., DYER, B.M., KLAGES, N.T.W., MEŸER, M.A. & UPFOLD, L. 2007a. Trends in numbers of Cape Gannets (*Morus capensis*), 1956/57–2005/06, with a consideration of the influence of food and other factors. *ICES Journal of Marine Science* 64: 169–177.

CRAWFORD, R.J.M., DYER, B.M., KEMPER, J., SIMMONS, R.E. & UPFOLD, L. 2007b. Trends in numbers of Cape Cormorants (*Phalacrocorax capensis*) over a 50-year period, 1956–57 to 2006–07. *Emu* 107: 1–9.

CRAWFORD, R.J.M., COCKROFT, A.C., DYER, B.M. & UPFOLD, L. 2008a. Divergent trends in Bank Cormorants *Phalacrocorax neglectus* breeding in South Africa's Western Cape consistent with a distributional shift of Rock Lobsters *Jasus lalandii*. *African Journal of Marine Science* 30: 161–166.

CRAWFORD, R.J.M., MAKHADO, A.B., UPFOLD, L. & DYER, B.M. 2008b. Mass on arrival of Rockhopper Penguins at Marion Island correlated with breeding success. *African Journal of Marine Science* 30: 185–188.

CRAWFORD, R.J.M., SABARROS, P.S., FAIRWEATHER, T., UNDERHILL, L.G. & WOLFAARDT, A.C. 2008c. Implications for seabirds of a long-term change in the distribution of sardine: a South African experience. *African Journal of Marine Science* 30: 171–184.

CRAWFORD, R.J.M., TREE, A.J., WHITTINGTON, P.A., VISAGIE, J., UPFOLD, L., ROXBURG, K.J., MARTIN, A.P. & DYER, B.M. 2008d. Recent distributional changes of seabirds in South Africa: is climate having an impact? *African Journal of Marine Science* 30: 189–193.

DE MOOR, C.L., BUTTERWORTH, D.S., COETZEE, J.C. 2008. Revised estimates of abundance of South African sardine and anchovy from acoustic surveys adjusting for echosounder saturation in earlier surveys and attenuation effects for sardine. African Journal of Marine Science 30: 219-232.

DUNLOP, J.N. & WOOLER, R.D. 1986. Range extensions and the breeding seasons of seabirds in south-western Australia. *Records of the Western Australian Museum* 12: 389–394.

DU TOIT, M., BOERE, G.C., COOPER, J., DE VILLIERS, M.S., KEMPER, J., LENTEN, B., SIMMONS, R.E., UNDERHILL, L.G. & WHITTINGTON, P.A. (Eds). 2003. Conservation assessment and management plan for southern African coastal seabirds. Cape Town, South Africa: Avian Demography Unit and Apple Valley: Conservation Breeding Specialist Group.

EVERY, B. 1975. The Roseate Tern at Cape Recife. *Bokmakierie* 27: 59–60.

EVERY, B. 1979. Damara Tern in Eastern Cape. *The Bee-eater* 30: 1–2.

EVERY, B. 1983. Second record of mainland breeding by the Jackass Penguin *Spheniscus demersus*. *Cormorant* 11: 62.

FAIRWEATHER, T.P., VAN DER LINGEN, C.D., BOOTH, A.J., DRAPEAU, L. & VAN DER WESTHUIZEN, J.J. 2006. Indicators of sustainable fishing for South African Sardine (*Sardinops sagax*) and Anchovy (*Engraulis encrasicolus*). *African Journal of Marine Science* 28: 661–680.

GRÉMILLET, D., DELL'OMO, G., RYAN, P.G., PETERS, G., ROPERT-COUDERT, Y. & WEEKS, S.J. 2004. Offshore diplomacy, or how seabirds mitigate intra-specific competition: a case study based on GPS tracking of Cape Gannets from neighbouring colonies. *Marine Ecology Progress Series* 268: 265–279.

HEATH, R.G.M. & RANDALL, R.M. 1989. Foraging ranges and movements of Jackass Penguins (*Spheniscus demersus*) established through radio telemetry. *Journal of Zoology* 217: 367–379.

HOCKEY, P.A.R., DEAN, W.R.J. & RYAN, P.G. (Eds). 2005. Roberts birds of Southern Africa. Seventh edition. Cape Town, South Africa: Trustees of the J. Voelcker Bird Book Fund. 1296 pp.

HOSTEN, L. 1981. Breeding of Blackwinged Stilts at Fishwater Flats. *The Bee-eater* 32: 3.

KLAGES, N.T.W., WILLIS, A.B. & ROSS, G.J.B. 1992. Variability in the diet of the Cape Gannet at Bird Island, Algoa Bay, South Africa. *South African Journal of Marine Science* 12: 761–771.

MARTIN, A.P. 1988. Rarities around Port Elizabeth. *The Bee-eater* 39: 4–5.

MARTIN, A.P. 2001a. Recent reports. *The Bee-eater* 52: 14–16.

MARTIN, A.P. 2001b. Recent reports. *The Bee-eater* 52: 56–58.

MARTIN, A.P. 2002. Recent reports. *The Bee-eater* 53: 51–54.

MARTIN, A.P. & BAIRD, D. 1987. Seasonal abundance and distribution of birds on the Swartkops Estuary, Port Elizabeth. *Ostrich* 58: 122–134.

MARTIN, A.P. & RANDALL, R.M. 1987. Numbers of waterbirds at a commercial saltpan, and suggestions for management. *South African Journal of Wildlife Research* 17: 75–81.

MARTIN, A.P. & TAYLOR, A. 2002. First breeding of Damara Tern at Cape Recife. *The Bee-eater* 53: 11.

MCINNES, A.M. 2006. Biology of the Grey-headed Gull *Larus cirrocephalus* in South Africa [MSc thesis]. Pietermaritzburg, KwaZulu–Natal: University of KwaZulu–Natal. 208 pp.

NICHOLLS, G. 1977. A new gull for the Eastern Cape. *The Bee-eater* 28: 36.

PETERSEN, S.L., RYAN, P.G. & GREMILLET, D. 2005. Is food availability limiting African Penguins at Boulders?: a comparison of foraging effort at mainland and island colonies. *Ibis* 147: 14–26.

RAND, R.W. 1963. The biology of guano-producing seabirds. 4. Composition of colonies on the Cape islands. *Investigational Report Sea Fisheries Research Institute South Africa* 43: 1–32.

RANDALL, R.M. & MCLACHLAN, A. 1982. Damara Terns breeding in the Eastern Cape, South Africa. *Ostrich* 53: 50–51.

RANDALL, R.M. & RANDALL, B.M. 1980. Status and distribution of the Roseate Tern in South Africa. *Ostrich* 51: 14–20.

RANDALL, R. & ROSS, G.J.B. 1979. Increasing population of Cape Gannets on Bird Island, Algoa Bay, and observations on breeding success. *Ostrich* 50: 168–175.

RANDALL, R.M., RANDALL, B.M., BATCHELOR, A.L. & ROSS, G.J.B. 1981. The status of seabirds associated with islands in Algoa Bay, South Africa, 1973–1981. *Cormorant* 9: 85–104.

RANDALL, R.M., RANDALL, B.M., COOPER, J. & FROST, P.G.H. 1986. A new census method for penguins tested on Jackass Penguins *Spheniscus demersus. Ostrich* 57: 211–215.

RANDALL, R.M., RANDALL, B.M. & RALFE, M. 1991. Roseate Terns in South Africa: population size, revision of previous estimate and conservation. *Bontebok* 7: 1–6.

ROY, C., VAN DER LINGEN, C.D., COETZEE, J.C. & LUTJEHARMS, J.R.E. 2007. Abrupt environmental shift associated with changes in the distribution of Cape anchovy *Engraulis encrasicolus* spawners in the southern Benguela. *African Journal of Marine Science* 29: 309–319.

SHELTON, P.A., CRAWFORD, R.J.M., COOPER, J. & BROOKE, R.K. 1984. Distribution, population size and conservation of the Jackass Penguin *Spheniscus demersus. South African Journal of Marine Science* 2: 217–257.

SKEAD, C.J. 1967. Ecology of birds in the Eastern Cape Province. *Ostrich Supplement* 7: 1–103.

TREE, A.J. 2000a. Out-of-season Damara Terns at Cape Recife. *The Bee-eater* 51: 55.

TREE, A.J. 2000b. Further on the Damara Terns at Cape Recife. *The Bee-eater* 51: 19.

TREE, A.J. 2001. A hitherto unrecorded Kelp Gull breeding colony at the Gamtoos mouth. *The Bee-eater* 52: 4.

TREE, A.J. 2002. Analysis of tern counts from the Eastern Cape coastline. *The Bee-eater* 53: 3–11.

TREE, A.J. 2005. The known history and movements of the Roseate Tern *Sterna dougallii* in South Africa and the western Indian Ocean. *Marine Ornithology* 33: 41–47.

TREE, A.J. 2006. An eastward extension of Kelp Gull breeding activity. *The Bee-eater* 57: 58.

UNDERHILL, L.G., COOPER, J. & WALTNER, M. 1980. The status of waders (Charadrii) and other birds in the coastal region of the southern and eastern Cape, summer 1978/79. Cape Town, South Africa: Western Cape Wader Study Group. 208 pp.

UNDERHILL, L.G., CRAWFORD, R.J.M., WOLFAARDT, A.C., WHITTINGTON, P.A., DYER, B.M., LESHORO, T.M., RUTHENBERG, M., UPFOLD, L. & VISAGIE, J. 2006. Regionally coherent trends in colonies of African Penguins *Spheniscus demersus* in the Western Cape, South Africa, 1987–2005. *African Journal of Marine Science* 28: 697–704.

WATSON, J.J. 1995. Dune-breeding birds and human use of the Alexandria coastal dunefield: interactions and management implications [MSc thesis]. Port Elizabeth, Zaire: University of Port Elizabeth. 79 pp.

WATSON, J.J. & KERLEY, G.I.H. 1995. A survey of the dune-breeding birds in the Eastern Cape, South Africa. *Ostrich* 66: 15–20.

WHITTINGTON, P.A. 2004. New breeding locality for Crowned Cormorant. *Koedoe* 47: 125–126.

WHITTINGTON, P.A. & KLAGES, N.T.W. 2006. Tourism options for the Alexandria dunefield and beach. Limiting impacts on breeding and resident avifauna. IECM Report C140. Prepared for South African National Parks. Port Elizabeth: Whittington, P.A. & Klages, N.T.W. . 43 pp.

WHITTINGTON, P.A., KLAGES, N.T.W. & MARTIN, A.P. 2006a. Seasonal patterns in numbers of Kelp Gulls *Larus dominicanus vetula* in the Port Elizabeth area and on Bird Island, Algoa Bay. *Ostrich* 77: 195–201.

WHITTINGTON, P.A., MARTIN, A.P. & KLAGES, N.T.W. 2006b. Status, distribution and conservation implications of the Kelp Gull *Larus dominicanus vetula* within the Eastern Cape region of South Africa. *Emu* 106: 127–139.

WILSON, R.P. 1985. The Jackass Penguin (*Spheniscus demersus*) as a pelagic predator. *Marine Ecology Progress Series* 25: 219–227.

WILSON, R.P. & WILSON, M.P.T. 1990. Foraging ecology of breeding *Spheniscus* penguins. In: Davis, L.S. & Darby, J.T. (Eds). Penguin biology. San Diego, California: Academic Press. pp. 181–206.