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A recent increase of swift terns *Thalasseus bergii* off South Africa – The possible influence of an altered abundance and distribution of prey

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ABSTRACT

In the 2000s, there were large increases in the numbers of swift terns *Thalasseus bergii* breeding in the Western and Eastern Cape Provinces of South Africa, which are most plausibly attributed to good recruitment and to an increase in the proportion of mature birds breeding. Numbers increased coincidentally with a greatly increased abundance of two of the main prey species of swift terns, sardine *Sardinops sagax* and anchovy *Engraulis encrasicolus*, and remained high as these resources decreased. After 2005, numbers of swift terns breeding in the north and central portions of the Western Cape decreased, whereas numbers breeding farther south in that province increased. This followed displacements to the south and east of sardine and anchovy. In southern Africa, swift terns show low fidelity to breeding localities, which enables a rapid adjustment of the location of breeding to an altered availability of prey. For two seabirds that feed mainly on sardine and anchovy, but once breeding show high fidelity to colonies, African penguin *Spheniscus demersus* and Cape gannet *Morus capensis*, proportions breeding in the south and east also increased, but there were substantial decreases in overall numbers breeding in the Western Cape.

1. Introduction

Food may limit populations of seabirds through affecting parameters such as breeding success, age at breeding, breeding participation and survival (e.g. Cairns, 1987; Hunt et al., 1996). Food has had a major influence on seabird numbers in upwelling systems (e.g. Crawford and Jahncke, 1999). For Cape gannets at colonies in the Benguela ecosystem off Namibia and South Africa, frequency of attendance at nests, energy content of food delivered to chicks and body condition of adults were positively related to the rate of change of colony size, whereas foraging trip duration was negatively related to the rate of change, indicating poorer feeding conditions at decreasing colonies (Lewis et al., 2006).

The availability of food is influenced by its distribution as well as its abundance. In Namibia, numbers of African penguins *Spheniscus demersus* and Cape gannets *Morus capensis*, which breed in the south of that country (Fig. 1), decreased by more than 85% after the collapse in the late 1960s and early 1970s of the Namibian sardine *Sardinops sagax* (Crawford, 2007), their main food at the time (93–99% by mass; Matthews, 1961). The decrease of penguins commenced before that of gannets. The range of sardine contracted to the north as the stock collapsed (Crawford et al., 1987). Gannets have a considerably greater foraging range than penguins when breeding (e.g. Heath and Randall, 1989; Grémillet et al., 2004; Petersen et al., 2006) and were able to exploit sardine for a longer period than penguins (Crawford, 2007).

In the late 1990s and early 2000s, sardine was abundant off South Africa but its distribution shifted substantially to the south and east (Fairweather et al., 2006; Coetzee et al., 2008). Similarly, there was an eastward displacement of anchovy *Engraulis encrasicolus* (Roy et al., 2007), another important prey item for African penguins and Cape gannets (Hockey et al., 2005). This led to a mismatch in the distributions of the breeding localities and prey of gannets and penguins in South Africa's Western Cape Province and decreases in both species, notably penguins (Crawford et al., 2008a,b). However, in the Eastern Cape Province numbers of gannets increased as sardine became more available (Crawford et al., 2007, 2008a).

Another seabird that feeds substantially on sardine and anchovy in South Africa is the swift (or greater crested) tern *Thalasseus bergii*: from 1991 to 1993, sardine and anchovy formed 67–83% by mass of the diet (Crawford and Dyer, 1995). The nominate race of this species is endemic to southern Africa, breeding in Namibia and South Africa's Western and Eastern Cape Provinces (Fig. 1; Cooper et al., 1990). In 2006, it was estimated that the overall population of *T. b. bergii* numbered some 9000 breeding pairs (Kemper et al., 2007).

This paper documents recent changes in the numbers of swift terns breeding in the Western and Eastern Cape Provinces and

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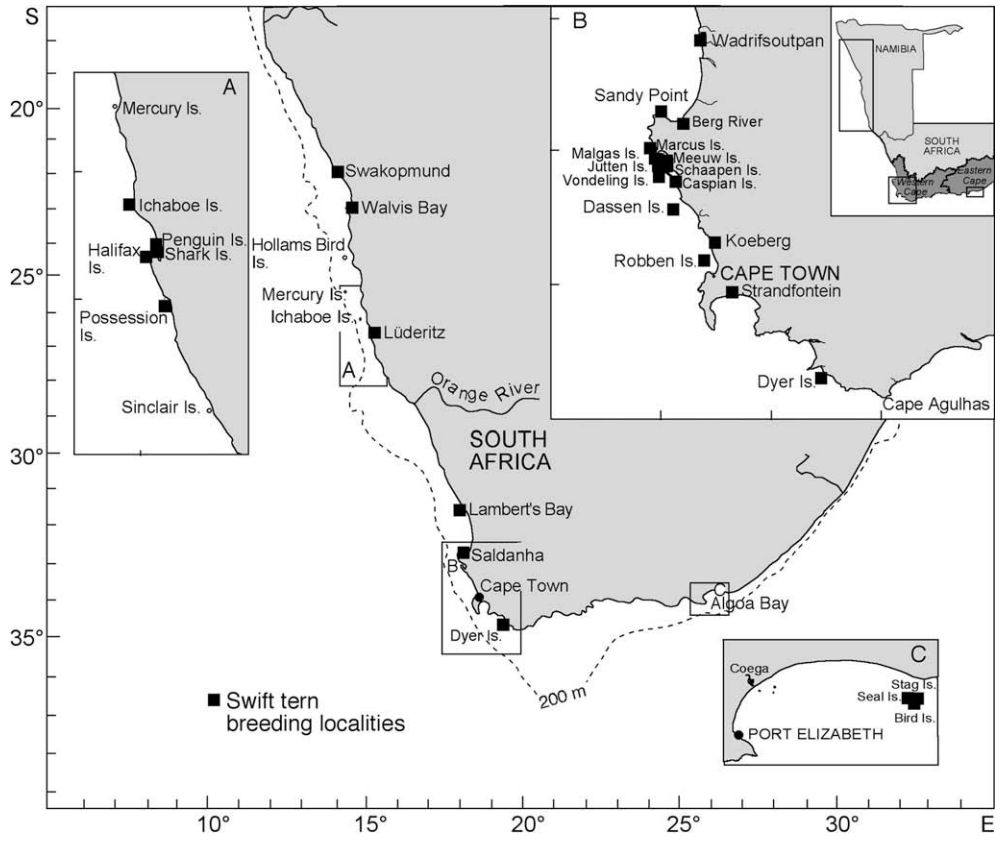

Fig. 1. The locations of breeding localities of swift terns off southern Africa (solid squares), showing other localities mentioned in the text. Off Namibia, African penguins breed at localities between Hollams Bird and Sinclair islands and Cape gannets at Mercury, Ichaboe and Possession islands.

considers how they may have been influenced by the abundance, and recent south and east displacements, of sardine and anchovy. It compares the responses of swift terns to the altered distribution of prey with those of African penguins and Cape gannets. Unlike African penguins and Cape gannets, swift terns show low fidelity to breeding localities (Crawford et al., 2002; Crawford, 2003) and so might be expected more rapidly to adjust their breeding distributions to an altered distribution of prey.

2. Methods

Swift terns have recently bred at 17 localities in the Western Cape and at four in the Eastern Cape (Fig. 1). In the Western Cape, most known breeding localities were checked in 1984 and annually from 1987 to 2008 during the breeding season, which is January–June (Crawford et al., 2002). In some years, certain localities were not visited, as indicated in Table 1, but this is not thought greatly to have affected the number estimated to be breeding in any year (Crawford, 2003). Counts of the number of breeding pairs were made as described by Cooper et al. (1990). Usually one count was conducted per breeding season; where more counts were made the maximum count was used (Crawford, 2003). Counts up to 2000 have been documented previously (Cooper et al., 1990; Crawford and Dyer, 1995; Crawford, 2003).

In the Eastern Cape, estimates of the numbers of swift terns breeding are available for 1978 (Randall et al., 1981), 1984 (Cooper et al., 1990), 1992, 1999, 2000, 2001 and 2008 (Crawford et al., in press). They were obtained by similar counting methods during the main breeding season in the Eastern Cape, which is May–July (Randall et al., 1981). However, information is less comprehensive.

For both provinces, it was assumed that the number of pairs breeding in any given year was the sum of the maximum counts obtained at each locality in that year. It is possible that in some instances swift terns abandoned breeding at one locality and moved to a second locality to breed. On a few occasions, counts may have been duplicated and the estimate of numbers breeding may be too high.

In the Western Cape, breeding localities were grouped into three regions: north – localities to the north of Saldanha (Lambert's Bay, Wadrifsoutpan, Berg River, Sandy Point); central – localities from Saldanha to Dassen Island (Saldanha and Malgas, Marcus, Jutten, Meeuw, Schaapen, Vondeling, Caspian and Dassen islands); and south – localities to the south of Dassen Island (Koeberg, Robben Island, Strandfontein and Dyer Island).

Estimates of the spawner biomass of sardine and anchovy off South Africa were available for 1984–2007 (de Moor et al., 2008). The proportion of biomass that was found east of Cape Agulhas was available for both these fish species (Roy et al., 2007; Coetzee et al., 2008). These indices provide an indication of the abundance and distribution of sardine and anchovy off South Africa.

The influence of the abundance and distribution of sardine and anchovy on numbers of swift terns breeding in the Western Cape was investigated through correlation analysis. Because swift terns breed early in each year, numbers breeding were related to indices of fish abundance and distribution in the preceding year. Counts of terns in the Eastern Cape were too sporadic to permit such analysis.

Swift terns feed by plunge diving or dipping, usually in the top 1 m of water (Hockey et al., 2005). Therefore, only fish near the surface are available as food. However, from 1987 to 2000, numbers of swift terns breeding in the Western Cape were significantly related to the combined biomass of sardine and anchovy (Crawford, 2003), suggesting that the availability of these fish species to swift terns is a function of their biomass.