RESPONSES OF AN ANTARCTIC SOUTHERN GIANT PETREL POPULATION TO CLIMATE CHANGE

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Abstract: *The comprehension of species responses to climate change is one of our present ecological challenges. This paper aims to evaluate the demographic responses of a Southern Giant Petrel population according to climate factors. We used a Multi-State Mark-Recapture method to estimate survival from breeder and non-breeder, and transition rates. Breeder survival response to Southern Oscillation Index, Antarctic Oscillation Index and temperature. Non breeder survival response to Southern Oscillation Index and temperature and Desertion rate with response to Temperature only in summer. Southern Giant Petrels are associated with warmer sea conditions. No recent decrease caused by climate factors can be expected under the scenario of warming in Antarctic Peninsula, and actual population size makes this assumption reasonable.*

Keywords: Antarctic oscillation, demography, El Niño Southern oscillation

Introduction

The annual variations of the El Niño Southern Oscillation are influential over the Antarctic Circumpolar Current (ACC). Anomalies on the ACC are directly correlated with atypical variations in the seasonal cycles of sea ice caps, disrupting trends on ocean and atmospheric temperature in Antarctica by affecting the Antarctic Oscillations (Gong & Wang, 1999; Kwok & Comiso, 2002).

Seabirds that breed at higher latitudes are affected by these climate variations through a disruption in demography rates (Warren *et al.*, 2009), population size (Ainley *et al.*, 2005) and increased area of dispersion to the north of Juvenile after fledging (Sander *et al.*, 2010). The present paper evaluates the demographic response of an Antarctic Southern Giant Petrel (SGP) population to the Southern Oscillation Index (SOI), Antarctic Oscillation Index (AOI) and temperature in the 80s. The demography responses of Antarctic seabirds to climate are unknown for most species. Therefore the present paper contributes to the knowledge about the influence of climate under the Antarctic biota.

Materials and Methods

The study was conducted at Elephant Island, South Shetlands, precisely at Stinker Point (61° 07' 31"S and 55° 19' 26" W). Adult Southern Giant Petrels (*Macronectes giganteus*) were banded and recovered from 1986/1987 until 1993/1994 with aluminum bands supplied by the National Center for Conservation of Wild Birds (CEMAVE, Portuguese acronym). For evaluation of survival rates of breeder and non-breeder stages we used a Multi-State Mark-Recapture Model using the data collected between 1986 and 1992. Breeding seasons: 1986-87, 1987-88, 1988-1989, 1989-90; 1990-91, 1991-92. The stages breeder and non breeder were used for the analysis. We evaluated whether the responses of survival, recapture and transition probabilities were constants or time dependents through a multi-model inference with AICc classification of best models using the Mark software. We used the rates from the 64 resulting models in a forward analysis. Demography responses to climate were tested through Analysis of Covariance ANCOVA by PASW 18.0, with $\alpha = 95\%$.

Results

The average SOI presented a greater variation along the years than the AOI, while SOI tended to be lower in summer in the last three years of the study (Figure 1). Average temperature tended to remain positive in summer (but got close to 0 °C in the last two years) and negative in winter, with a peak in the 1989 winter, when it reached -1 °C (Figure 2).

Breeder survival (BS) and non breeder survival (NBS) tended to show decline throughout all the years, while

desertion rate (DR) showed an increasing trend. Return rate (RR) was constant along the years (Figure 3). BS answered to SOI in winter and summer, AOI in summer and to temperature in winter. The greater slope was positive: AOI in summer. NBS answered only to SOI and temperature in winter, with a greater slope in winter SOI, but both values very closed. DR was only related to temperature in summer (negative slope) and RR was not related to any climate variable (Table 1, Figure 3).

Figure 1. Year average Antarctic Oscillation Index AOI (left) and Southern Oscillation Index SOI (right) in Summer (red line) and Winter (blue line). Errors bars are standard error.

Figure 2. Year average temperature in Summer (red line) and Winter (blue line). Errors bars are standard error.

Figure 3. Average variation of breeder survival (BS), non-breeder survival (NBS), desertion rate (DR) and return rate (RR) in the breeding seasons. Error bars are standard error.

Discussion

Adults are less responsive to environmental variability nonetheless minimal variations on the survival causes pronounced decreases on the population growth rate (Barbraud *et al.*, 2010). The standard trend in Stinker Point seems to be: higher temperatures in both summer and winter enhance survival and reduce desertion from breeding. Higher SOI and AOI mean higher temperatures in Antarctica (Gong & Wang, 1999; Kwok & Comiso, 2002). For breeders, the summer component must be the most important, since during breeding the energy expenditure to raise a chick overlaps with energy spent on survival. Other sub-Antarctic and temperate-water seabird's adult survival are affected by temperature and SOI (Croxall *et al.*, 2002;

Rolland *et al.*, 2010). As a consequence of the actual trend for Antarctic Peninsula region of warming, one can expect this population may not suffer declines caused by climate change. Such enhances can be considered probable, since the actual population numbers are greater than those from the studied years.

Conclusion

SGPs from Stinker Point are associated with warmer sea conditions. Their survival is probably enhanced by the current scenario of warming in the Antarctic Peninsula, as consequence no impending decrease caused by climate factors can be expected.

Table 1. ANCOVA results of demography responses for climate variables by a Southern Giant Petrel population in Elephant Island.

Dependent	Climate	Season	F	Slope	SE	P
BS	SOI	Winter	7.10	-11.73	4.40	0.016
		Summer	10.70	12.36	3.78	0.005
	AOI	Winter	2.85	-17.83	10.56	0.110
		Summer	5.75	29.19	12.18	0.028
	T (°C)	Winter	7.72	10.55	3.15	0.004
		Summer	9.36	-6.45	8.18	0.441
NBS	SOI	Winter	11.84	14.76	4.29	0.003
		Summer	0.87	-3.42	3.68	0.365
	AOI	Winter	2.29	17.16	11.33	0.148
		Summer	0.11	4.29	13.07	0.746
	T (°C)	Winter	11.25	10.55	3.15	0.004
		Summer	0.62	-6.45	8.18	0.441
DR	SOI	Winter	0.31	-2.67	4.82	0.587
		Summer	2.46	-6.48	4.13	0.136
	AOI	Winter	0.18	-4.47	10.60	0.679
		Summer	3.10	-21.53	12.22	0.096
	T (°C)	Winter	0.18	-1.41	3.34	0.678
		Summer	4.42	-18.28	8.69	0.051
RR	SOI	Winter	0.51	3.98	5.59	0.486
		Summer	0.07	-1.28	4.80	0.792
	AOI	Winter	2.21	-16.71	11.23	0.155
		Summer	0.04	-2.70	12.95	0.837
	T (°C)	Winter	0.14	1.38	3.70	0.713
		Summer	3.06	-16.79	9.61	0.099

SOI: southern oscillation index; AOI: Antarctic oscillation index; BS: breeder survival; NBS: non-breeder survival; DR: desertion rate; RR: return rate; F: fisher's statistics; SE: standard error; P: significance probability.

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