The following supplement accompanies the article

Influence of local and regional prey availability on breeding performance of African penguins *Spheniscus demersus*

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Supplement 1. Additional information on the study and results

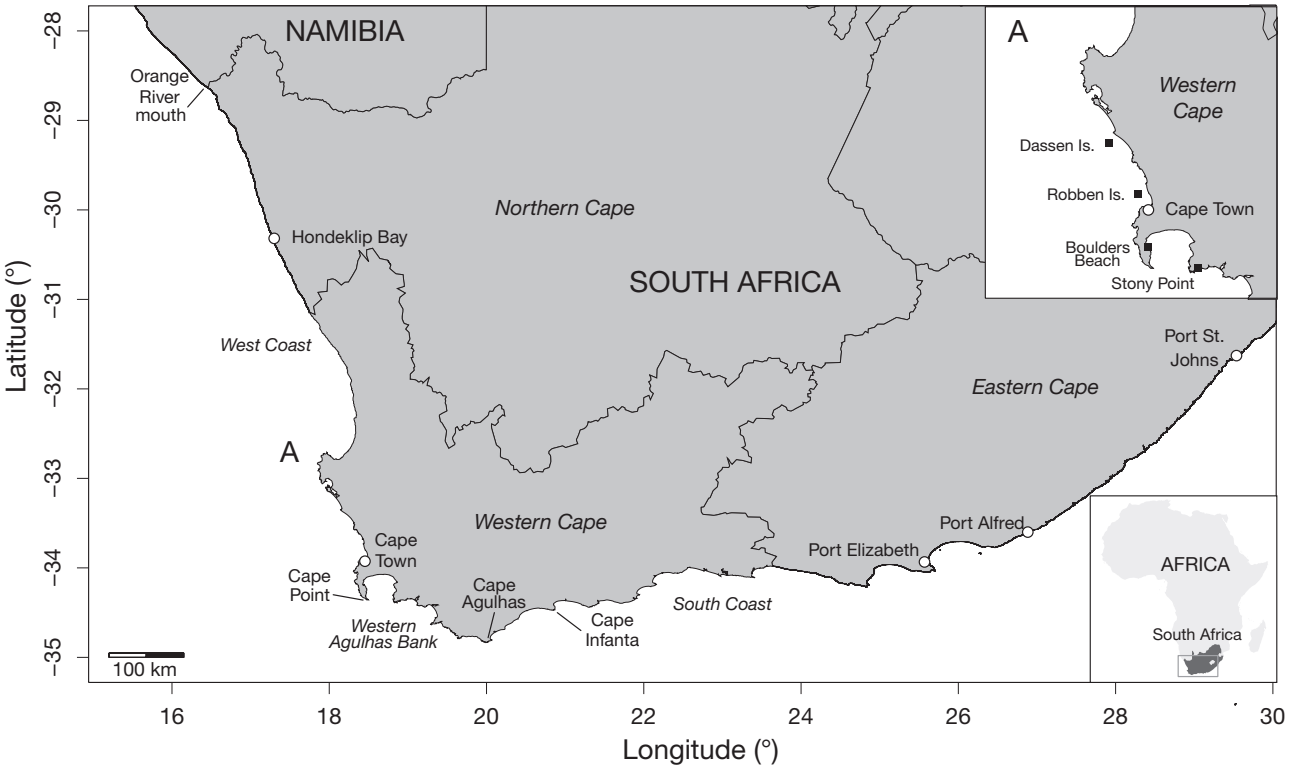

Fig. S1. The South African coastline showing the major marine areas, settlements (○) and African penguin colonies (■) referred to in the main article. The West Coast extends from the Orange River mouth to Cape Point, the Western Agulhas Bank from Cape Point to Cape Agulhas and the South Coast from Cape Agulhas to Port Alfred

Additional information on the diet of African penguins and the data used in the present study

The information on African penguin diet used here is based on samples collected at Robben Island by the Department of Environmental Affairs (South Africa) from 1989 to 2009. These data have been summarised recently by Crawford et al. (2011).

Penguins were caught during the breeding season on their way from the sea to inland nesting sites at dusk. Therefore, samples are likely to reflect the diet of chick-rearing or incubating birds. Food was obtained from the penguins' stomachs using a modified water-offloading technique (Wilson 1984), described in more detail by Crawford et al. (2011). For each sample, prey items were identified to the genus or species level (where possible) and weighed. The contribution by mass of different species to the diet was computed for each month, and annual estimates were obtained by apportioning equal weight to each month for which samples were collected (Crawford et al. 2011).

From 1989 to 2009, between 21 (in 1989) and 135 (1998) stomach samples were obtained each year (mean ± SD = 98 ± 27). Eighteen species were identified in the diet, along with some samples that could not be identified (labelled unidentified in Table S1) and some that could not be identified to species level (Table S1). The mean (±SD), minimum and maximum percentage contribution by mass are shown in Table S1. Anchovy *Engraulis encrasicolus* was by far the dominant prey item (Table S1). For the study period (2001 to 2009), between 51 and 117 stomach samples were obtained each year (mean ± SD = 90 ± 20). Anchovy contributed 64 to 98% of the pooled total mass in each year (Fig. S2) and a mean (±SD) of 86 ± 14%, while sardine contributed 0 to 6% of the total mass of prey items regurgitated at a mean of 1 ± 2%. If the diet constituents are considered in terms of their calorific content, the relative importance of sardine and anchovy increased marginally (Fig. S3) as they were amongst the most energy-rich prey species taken during the time-series (Table S1).

Table S1. Prey species identified in the diet of African penguins at Robben Island between 1989 and 2009 and the minimum, maximum and mean (±SD) percentage contribution to the penguin diet samples of each species (or group) along with the calorific content (wet mass, kJ g^{-1}) for each species or group (used to produce Fig. S3). For the fish species and squid, calorific content is based on estimates by Balmelli & Wickens (1994) or Cruickshank et al. (1980), with the average value for teleosts used where the specific values had not been estimated (5.91 kJ g^{-1}; Balmelli & Wickens 1994). For the crustaceans, an average value of 4.35 kJ g^{-1} was used following Croxall et al. (1984). Species are sorted in descending order by the mean contribution to the diet, and the top 5 species composed >85% of the diet by mass in all years

English name	Species name	Min. % by mass	Max. % by mass	Mean ± SD % by mass	Calorific content (kJ g^{-1})
Anchovy	*Engraulis encrasicolus*	55.9	98.1	83.9 ± 12.4	6.03[1]
Horse mackerel	*Trachurus capensis*	0.0	14.6	3.9 ± 5.2	5.65[1]
Sardine	*Sardinops sagax*	0.0	12.1	3.4 ± 4.0	6.59[1]
Round herring	*Etrumeus whiteheadi*	0.0	12.6	2.0 ± 3.2	5.91[1]
Squid	*Loligo* spp.	0.2	4.7	1.6 ± 1.3	4.70[1]
Beaked sandfish	*Gonorynchus gonorynchus*	0.2	6.4	1.5 ± 1.5	5.91[1]
Unidentified species		0.1	2.6	0.9 ± 0.8	5.91[1]
Cape hake	*Merluccius capensis*	0.0	5.5	0.7 ± 1.3	4.47[1]
Unidentified larval fish		0.0	5.5	0.6 ± 1.4	5.91[1]
Gurnard	*Chelidonichthys* spp.	0.0	4.2	0.5 ± 1.1	5.91[1]
Mantis shrimp	*Pterygosquilla armata capensis*	0.0	2.1	0.4 ± 0.6	4.35[2]
Longsnout pipefish	*Syngnathus acus*	0.0	1.0	0.2 ± 0.2	5.91[1]
Silvery lightfish	*Maurolicus muelleri*	0.0	2.2	0.1 ± 0.5	5.91[1]
Snoek	*Thyrsites atun*	0.0	0.4	0.1 ± 0.1	6.81[1]
Buttersnoek	*Lepidopus caudatus*	0.0	0.5	0.0 ± 0.1	5.91[1]
Southern mullet	*Liza richardsonii*	0.0	0.4	0.0 ± 0.1	5.91[1]
West Coast rock lobster	*Jasus lalandii*	0.0	0.4	0.0 ± 0.1	4.35[2]
Chub makerel	*Scomber japonicus*	0.0	0.3	0.0 ± 0.1	7.73[1]
Atlantic saury	*Scomberesox saurus*	0.0	0.4	0.0 ± 0.1	5.91[1]
Cape sandlance	*Gymnammodytes capensis*	0.0	0.0	0.0 ± 0.0	5.91[1]
Goby	Gobiidae	0.0	0.1	0.0 ± 0.0	3.69[3]
Slender snipe eel	*Nemichthys scolopaceus*	0.0	0.1	0.0 ± 0.0	5.91[1]

Sources: [1]Balmelli & Wickens (1994), [2]Croxall et al. (1984), [3]Cruickshank et al. (1980).

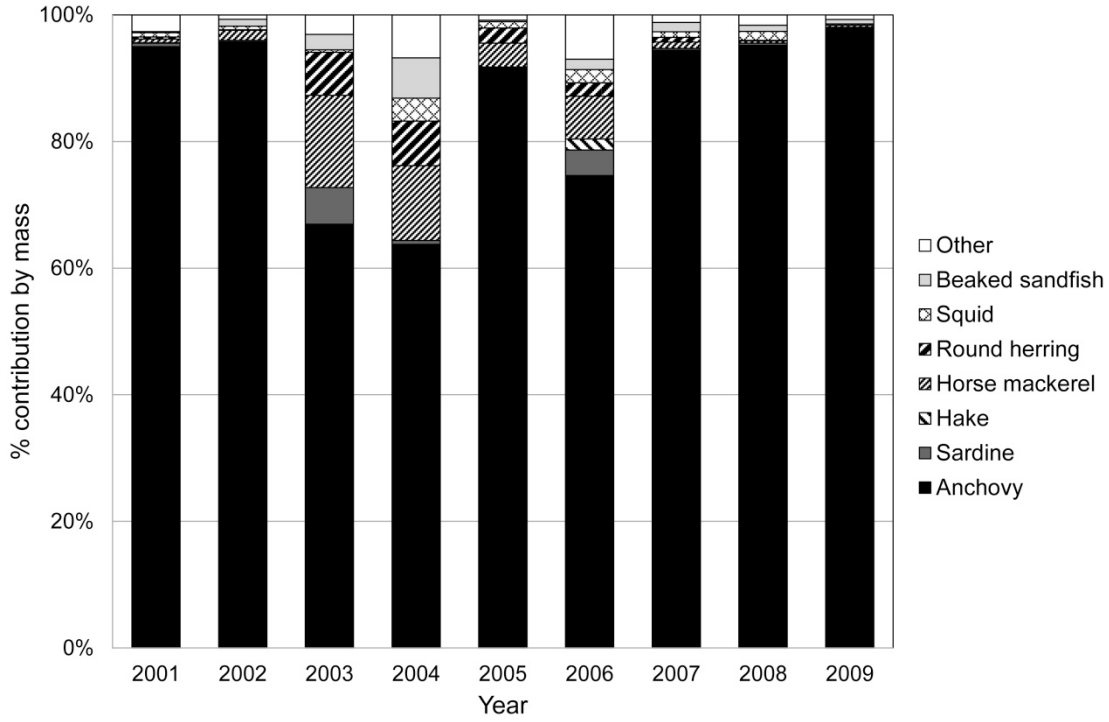

Fig. S2. The annual contribution (% by mass) of the species listed in Table S1 to the diet of adult African penguins returning to Robben Island during the breeding season, 2001 to 2009. For species names and a list of species contributing to the 'Other' category, see Table S1

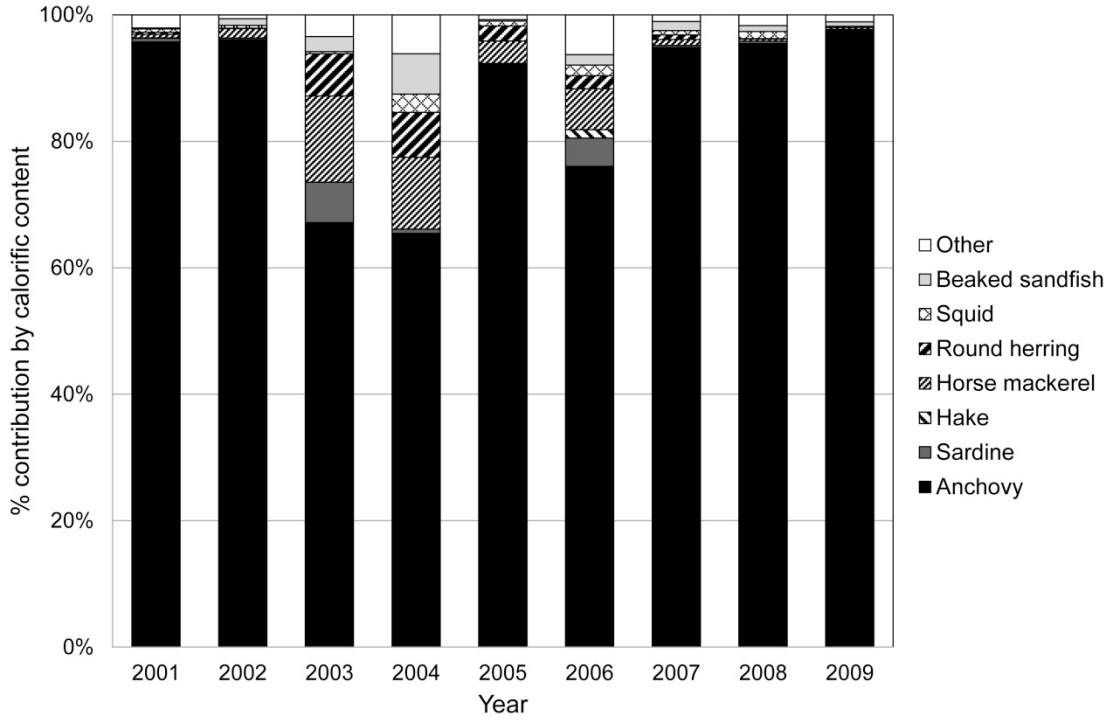

Fig. S3. The annual contribution (% by calorific content) of the species listed in Table S1 to the diet of adult African penguins returning to Robben Island during the breeding season, 2001 to 2009. For species names, a list of species contributing to the 'Other' category and the calorific content values used, see Table S1

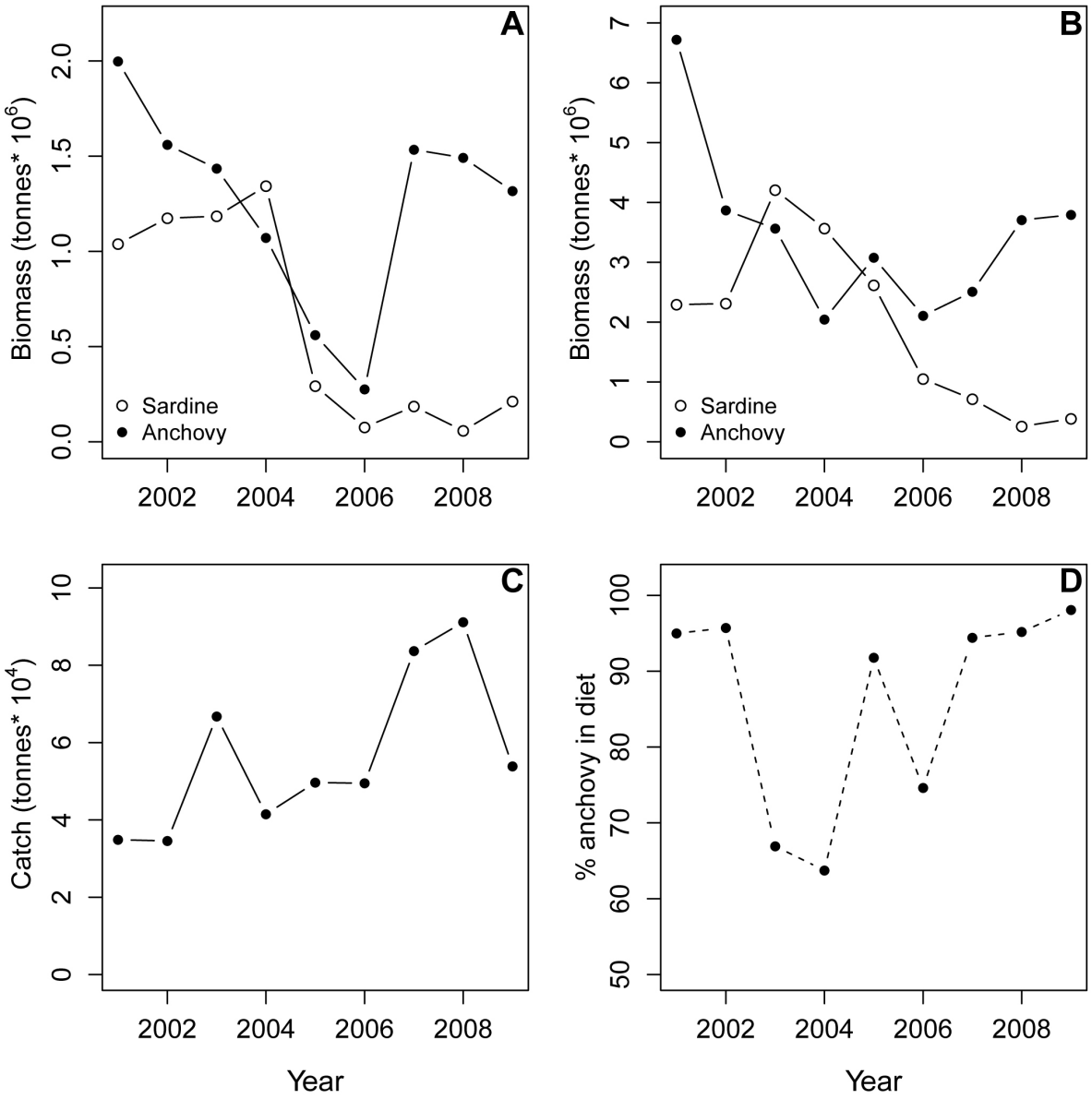

Fig. S4. Time series of the explanatory variables used in the present study: (A) the biomass of anchovy recruits (●) estimated from the May hydro-acoustic survey of the corresponding year (TotalRecAnch y_0; Table 1) and the estimated biomass of adult sardine (○) west of Cape Agulhas (West Coast and Western Agulhas Bank, Orange River mouth to Cape Agulhas, Fig. S1) from the November survey of the previous year (BioSardWA y_{-1}; Table 1); (B) the total biomass of anchovy (●) estimated from the November survey of the corresponding year (TotalBioAnch y_0; Table 1) and the total sardine (○) biomass estimated from the November survey of the previous year (TotalBioSard y_{-1}; Table 1); (C) the total annual catch of anchovy made within 56 km of Robben Island (CatchAnch y_0; Table 1); and (D) the annual percentage contribution of anchovy to the diet of African penguins at Robben Island (AnchPercDiet y_0; Table 1). Hydro-acoustic estimates of biomass and catch data were supplied by the Department of Agriculture, Forestry and Fisheries based on methods in de Moor et al. (2008) and Hutchings et al. (2009). Diet data are from Crawford et al. (2011)

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