Spatial and temporal components of female breeding strategies in southern elephant seals

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Abstract

Spatial and temporal factors are important components of breeding strategies. Breeding site fidelity and phylopatry may entail significant somatic benefits and costs, and may result in genetic substructure. Seasonality and synchrony of reproduction can be related to parental investment, breeding success and offspring survival. Longitudinal studies of breeding strategies in long-living species are rare. We studied breeding strategies of female southern elephant seals (*Mirounga leonina*) at Sea Lion Island (Falkland Islands) over 17 years.

Fig. 1 – Sea Lion Island from the air. Red lines indicate the study area, that includes all parts of the island used by elephant seals for breeding.

Female breeding was very regular at population level. We found evidence of strong phylopatry and parturition site fidelity. Each female showed high repeatability in the time components of her breeding strategy. Breeding site fidelity and regularity in the timing of breeding were related to aspects of female phenotype, but we found scarce evidence of an effect on female parental investment.

Introduction

Spatial and temporal aspects of breeding strategies have been rarely studied in long living species, due to the practical problems of prolonged data collection on identified individuals. Nevertheless, they are very important aspects of the breeding strategies of mammals. In fact, breeding site fidelity may entail significant benefits and costs and, if coupled with phylopatry, may result in genetic substructure. Similarly, seasonality and synchrony of breeding, at population and individual level, can be related to breeding success.

Methods

Field work was carried out at Sea Lion Island (Falkland Islands, Fig. 1), from 1995 to 2011. The island shelters a small and isolated population of elephant seals (516-595 breeding females). We marked 4405 females at birth together with 1123 females that were already breeders at the beginning of the study (1995-1999) (Fig. 2). Tag loss rate was low (Galimberti & Boitani 1999).

Fig. 2 – Marking with cattle tag, and a 16 years old tag, still readable.

We carried out daily censuses, GPS mapping, and behavior observations, to collected data about the number, identity, location, and status of females hauled out, and to determine the timing of breeding of each individual female (arrival on land, parturition, first and last copulation, departure to the sea). Pups were weighed at weaning, and weaning weight was used as a proxy of parental investment. Details on the data collection protocol can be found in Galimberti & Boitani (1999).

Results

Phylopatry and site fidelity

- 63.2% (95% CI = 46.5-77.4) of females gave birth the first time in the zone where they were born.
- 71.7 % (95% CI = 69.3-74.0%) of the females gave birth in the same zone of the previous year.
- The median distance of the parturition site in consecutive years was 340 m
- Females of larger size class showed greater site fidelity (Fig. 3).
- Experience (number of previous breeding seasons) and result of previous breeding attempt were not related to fidelity.

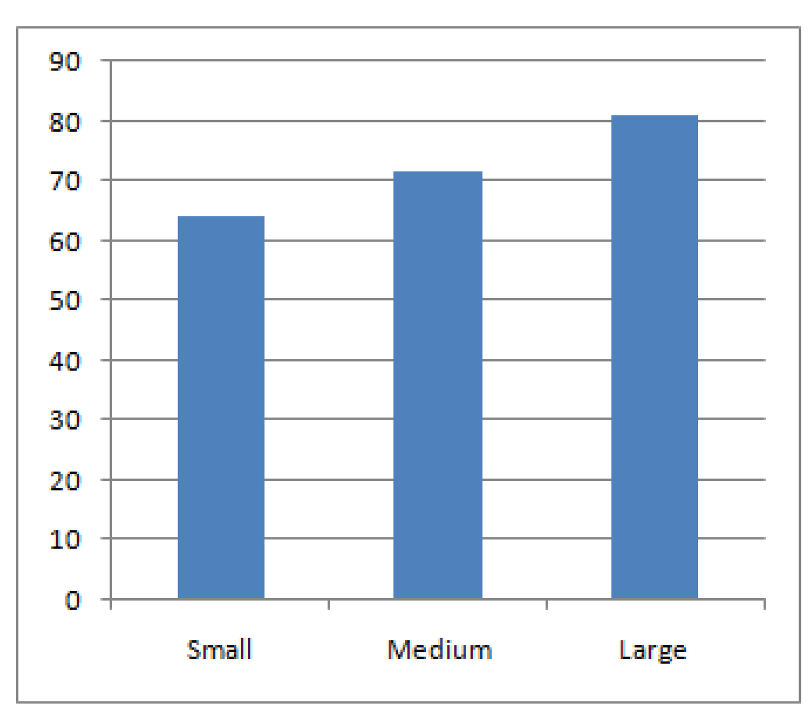

Fig.3 – Percentage of return to the same breeding zone by size class.

Breeding at population level

- Peak haul out was either on the 19th or the 20th of October (9 and 8 years, respectively).
- The percentage of females hauled out each day of the season showed a strong correlation among years (r = 0.983-0.999; Fig. 4).

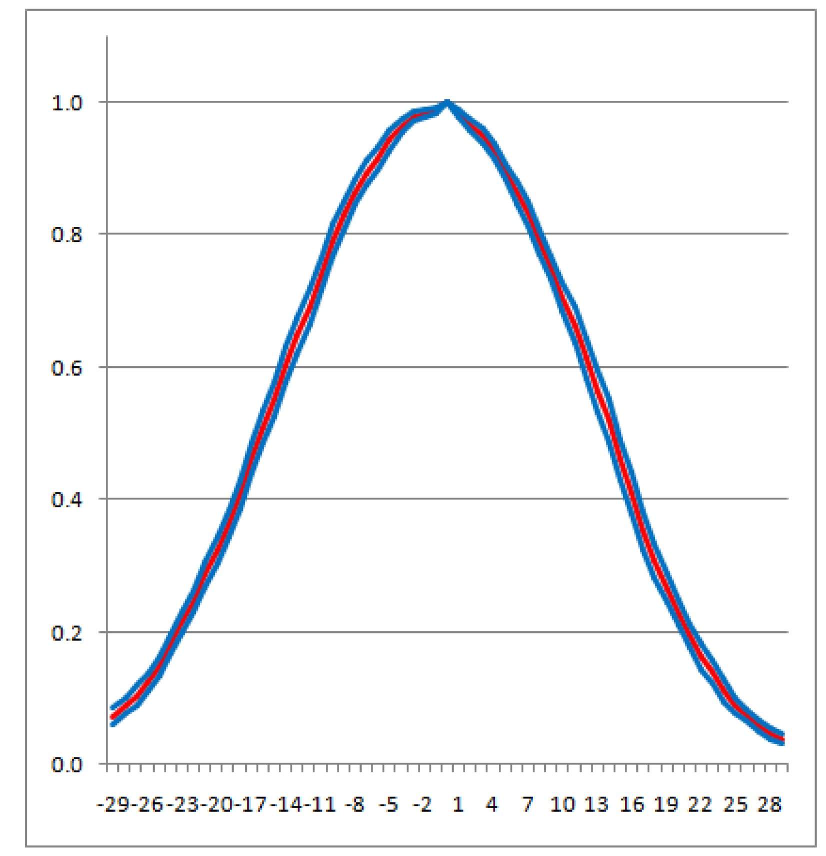

Fig. 4 – Proportion of females hauled out. Day 0 = peak day; red line = mean proportion; blue lines = 95% confidence limits of the mean proportion.

Breeding at individual level

- Breeding events of each female were repeatable (Tab. 1)
- Parturition day had a negative effect on duration of lactation, while size class had a positive effect (Tab. 2)
- Size had a positive effect on weaning weight, and day of parturition had a slight negative effect (Tab. 3).
- Other spatial and timing components had no effect on both duration of lactation and weaning weight.

Variable	R	SE(R)	Lower CL	Upper CL
Arrival on land	0.7329	0.0169	0.6998	0.7661
Parturition	0.7824	0.0137	0.7556	0.8092
Return to sea	0.7880	0.0130	0.7625	0.8135
First copulation	0.7773	0.0246	0.7291	0.8255
Last copulation	0.7712	0.0265	0.7194	0.8231

Tab. 1 – Repeatability of individual timing of breeding (bootstrapped SE and CL).

Variable	Coef.	Robust SE	Lower CL	Upper CL
Parturition day	-0.0737	0.0093	-0.0919	-0.0554
Year	0.0671	0.0640	-0.0584	0.1927
Primiparity	-0.3579	0.3159	-0.9770	0.2612
Breeding status	0.0902	0.8804	-1.6354	1.8159
Size class	0.2899	0.0289	0.2332	0.3466
Experience	-0.0592	0.0720	-0.2004	0.0820

Tab. 2 – Generalized estimating equation model for the duration of lactation.

Variable	Coef.	Robust SE	Lower CI	Upper CI
Parturition day	-0.6091	0.1180	-0.8405	-0.3778
Year	4.7250	1.8758	1.0486	8.4015
Primiparity	-2.2816	4.4267	-10.9578	6.3946
Size class	6.9127	0.5604	5.8146	8.0112
Experience	2.3045	0.9978	0.3489	4.2603

Tab. 3 – Generalized estimating equation model for weight at weaning of the pup.

Conclusions

- Phylopatry and site fidelity were strong, notwithstanding the lack of evident topographical features of Sea Lion Island sand beaches.
- At population level, breeding was strongly synchronized and regular among years.
- At individual level, the temporal components of each female breeding strategy were repeatable.
- Breeding site fidelity and regularity in timing of reproduction were related to female phenotype, and size in particular, but not to parental investment.

Literature cited

Galimberti, F. and L. Boitani (1999). Demography and breeding biology of a small, localized population of southern elephant seals (*Mirounga leonina). Marine Mammal Science 15(1): 159-178.*