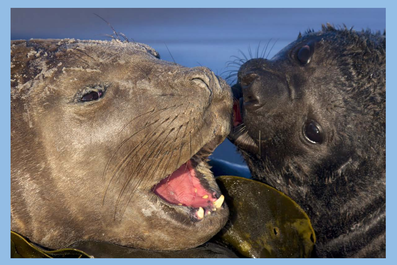
Elephant Seal Research Group

Elephant Seals of Sea Lion Island

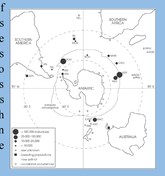
A long-term research project





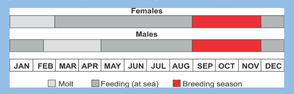

The elephant seals

The genus *Mirounga* comprises two species, the southern elephant seal (*M. leonina*) and the northern (*M. angustirostris*). The two species of the genus are similar in external appearance, behaviour at sea, and gross traits of social system. The first difference is male size: northern elephant seals maximum male weight is about 2300 kg versus 3700 kg for southern, while females have similar size. Male sexual traits are more developed in the northern species: in particular the trunk is much longer. The two species have similar breeding cycle, but they breed at different time of the year, January-February in the northern species, and September-November in the southern. Both species have dominance hierarchies among the males and male control of harems, but the mating system is less organized and more promiscuous in the northern species. Nursing of pups is similar, but northern females attend to the pup for longer than southern (4 weeks instead of 3). Southern elephant seals have a circum-antarctic distribution, with populations grouped in three main stocks: South Georgia (that includes the Falklands), Kerguelen and Macquarie.

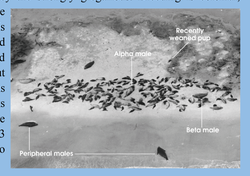



The southern elephant seal

Southern elephant seals have a mixed life style, with two aquatic phases (feeding) and two land phases (breeding and moulting).

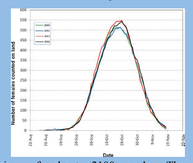


Feeding areas are usually far from the haul out sites. At sea they show a pattern of long and deep dives, feeding mainly on squids. They are able to deep dive up to 1500 m, while the mean dive depth is 500-600 m. The mean dive duration is 23 minutes, but up to more than one hour. Young seals, mature males and mature females have different feeding styles. They fast during the land phases. On land both males and females suffer a large weight loss, about 30-35 % for females and even more for males. Males show a significant growth spur at puberty, when their growth rate increases sharply. Pre-breeding mortality of males is high, and just 5-10% of each male cohort reaches full sexual maturity. Elephant seal forage alone, but on land they are strongly gregarious. Breeding is colonial, females gather in large groups and this produces a harem based mating system and strong polygyny. About 90% of copulations occur in a three weeks time. Females suckle their pup for about 23 days, and then return to sea, weaning the pup.



Elephant seals of Sea Lion Island

The population of Sea Lion Island is small and localized. Breeding happens almost only on the eastern sandy beaches, while moulters are found all around the island. There is no immigration of breeders but during the moult many individuals from other colonies are observed. Females begin to haul out during the second week of September, almost all females return to sea by the third week of November, and the day of peak female haul out is always the 19th or 20th of October. In recent years maximum number of hauled out females was about 550, i.e., a total of about 615 breeding females, and a total population size of about 2100 seals. The population has been almost steady, with fluctuations, until 2003, and then started growing at an average rate of 2%. Pup mortality is very low (1-3%), and sex ratio at birth is almost balanced. Estimated survival between breeding seasons is 67-78%, and about fifty percent for males. Median harem size is about 35 females, and maximum observed at peak was 152 females.



Marking: long term study of individuals

One of the main goal of our research is to collect information on a large sample of individuals of known age and with full history. This requires individual recognition through the use of artificial marking. Long term marking is accomplished by tagging. Two cattle tags are applied to the hind flippers of all pups, the first shortly after birth, and the second just after weaning. Between seasons tag loss rate is very low. To improve the quality of long term marking of pups, we implemented an electronic identification system based on passive implanted transponders (PIT). The main PIT advantage is the reduction of tag loss, while their obvious disadvantages are cost (~ 20 times the cost of a cattle tag), and the need to get close to the animal and use a sensing device to read the code. To recognize seals during social interactions, we mark breeders by painting name on their back and/or flanks using black hair dye. These marks are temporary: they usually last for the whole breeding season but are lost during the moult.

Observation of behaviour

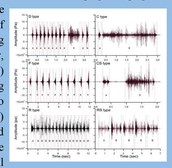
The core of our research project is the study of behaviour. Elephant seals are a very good subject to study the evolution of social behaviour, because they have an interesting social system, are easy to mark, and can be observed at close distance without affecting their behaviour. The first goal of our behavioural research is the study of the variation of male tactics and strategies of competition and breeding. Male agonistic behaviour comprises conventional assessment and direct aggression. Assessment through visual and acoustic threats is more frequent than direct aggression and it is used to settle the most of the contests, especially between males with large differences in size and/or age. Long all out fights, although less frequent, are used to define relationships between males with similar phenotype. The intense competition results in huge differences in reproductive success. Most males have limited access to females due to the despotic mating system, and their libido is high. Therefore, male molestation may be potentially a serious source of damage for female. The main short-term cost of harassment is disruption of the female's' activity schedule (e.g., suckling), but physical damage (e.g., wounds) is very rare.

Size and morphology

The most amazing fact about elephant seals is the huge difference in size and morphology between males and females. Males weigh up to four tons, and females to 700 kg. Males have the proboscis, enlarged canine teeth and a thick protective dermal shield in the chest. All these characters are the result of evolution by sexual selection: for example, larger canine teeth can give deeper bites during fights. Due to the large size, direct measurement of elephant seals is not easy. Moreover, the most puzzling trait, the trunk, should be measured while inflated to provide meaningfull data. Hence, we used photogrammetric methods to measure body length and size of the proboscis and canines. The area of the side outline measured in the picture is a very good estimator of weight. Body size is a very important component of male success in competition. Body length is positively correlated to fighting success and to the estimated number of females fertilized. Smaller males have a very low success. Among adult males, the largest ones have top ranks in dominance hierarchies, get the biggest harems, and sire most of the pups.

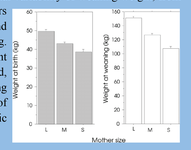
Acoustic communication

Acoustic communication is a very important component of elephant seal sociality. Interactions between males are often settled by vocalizations. To study male vocalizations we developed a recording protocol in which an operator act as the stimulus that evokes the vocalization. We studied vocalizations using spectrographic analysis. We showed that: a) males have distinct vocal types, that are the result of a learning process in which young males adopt the vocal type of the older, more dominant males of their area; b) vocalizations of each males have a long maturation process before they get to their final, structured form; c) information on size and age is encoded in the vocalizations, that can therefore be used for assessment. Vocal communication is also very important for females, because recognition of the pup is fundamental to establish the mother- pup bond that permit a successful suckling. Mothers and pups emit individually distinctive calls that permit reciprocal recognition. Vocal duets are very frequent after birth and during the first days of life.



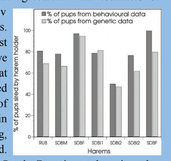
Maternal investment and pup weight

A core aspect of breeding strategies is maternal investment. Elephant seals are capital breeders, i.e., females feed at sea and fast while on land, suckling the pup by using the energy stored in blubber. Therefore, maternal investment can be measured by weighing pups at birth and at weaning. Pups are weighed using a canvas bag and a dynamometer held up by two people. Weanlings are weighed using a custom weighing bag, and the dynamometer is connected to a big tripod. No chemical restrain is used, weighing never resulted in pup physical damage or abandonment, and the whole procedure is brief (< 10 min). Mean birth weight is about 43 kg, and mean length is 130 cm, with males significantly heavier and slightly longer than females. The difference between the sexes almost disappear by weaning, when females weigh about 133 kg and males about 138. There is a huge individual variability of weaning weight, from 65 to 215 kg. Pups of bigger mothers are heavier and longer at birth, and they are also heavier at weaning. Weaning weight is an excellent proxy of females access to food and, therefore, its long term monitoring can be used to study the effect of climatic and oceanographic variability on the population status.



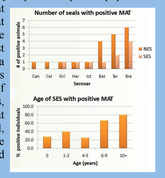
Genetics: individuals and populations

The development of new molecular tools greatly improved the study of biology of wild animals. We routinely collect skin samples by piercing a small piece of the rear flippers membrane. DNA is extracted from these samples, and molecular markers are typed to study different aspects of elephant seal biology. We studied genetic paternity of males and we found that actual paternity is in excellent agreement with estimates of reproductive success based on observed copulations. The harem holder was the father of most pups, regardless of harem size. Then, we studied female kinship, and we found that in some harems females are more related between themselves than with females of other harems. This may explain phenomena like adoption and fostering, that are anyway rare on Sea Lion Island. Lastly, we studied the genetic of the South Georgia stock, using also samples obtained in other populations, and we showed that the stock is almost homogeneous from a genetic point of view. During the genetic study we obtained evidences of a long range migration of a male from the very distant Macquarie Island colony, that is almost 8000 km away !



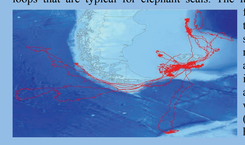
Population health: stress, pathogens

We are using multiple tools to assess population health. Monitoring of population trend and female access to resources through weaning weight were mentioned before. We are assessing the impact of human activity on seals by observing seal behaviour in presence of human beings or vehicles. We are studying the variation of cortisol, an hormone involved in the response to short term and chronic stress. We devised minimally invasive methods to get blood samples, including sampling from male natural wounds just after fights, and techniques to get blood from rear flippers of weaned pups in a very short time. Post handling cortisol titres of weaned pups are equal to the baseline titres, so we can safely assume that we are not producing any significant damage to the pups that we are weighing. A very important aspect of population health is exposure to pathogens, and that is even more important for pinnipeds that live both in the water and on land. We studied leptospirosis, that is the most widespread zoonosis, and can be a significant source of mortality in seals and sea lions. We obtained evidences of exposure to various *Leptospira* strains, increasing with age, but, contrary to what we found in the northern elephant seal, we found no evidence of current acute infection. All together the Sea Lion Island population seems to be pretty healthy.



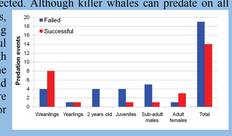
Movements at sea and foraging

A very important part of elephant sea life cycle is foraging at sea. We deployed a total of 24 satellite tags on females to track their movements at sea. This was the first tracking-at-sea project carried out on elephant seals of the Falklands. Sea Lion Island represents an ideal place for a tracking project, due to the tameness of the seals, the easiness of the logistics, and the availability of a large amount of background information on the subjects. The study produced some very interesting and unexpected results, with most seals foraging rather close to the Falklands and/or on the continental shelf. This is not for elephant seals, that usually forage very far away from the breeding colony. For example, female AXES reached a maximum distance from Sea Lion island of just 120 km. Only few females showed the very long loops that are typical for elephant seals. The fact that the majority of females forage close to the Falklands coast suggests that food resources are easily accessible, but also increases the chances of a negative interaction with human activities (e.g., fisheries and hydrocarbon industry).



Killer whales: population regulation

Although the seal population is currently increasing, its size is still small, and the good access of females to resources, indicated by the high average weaning weight, suggests that the population should increase at an higher rate. Therefore, there should be some unknown regulating factor. Killer whales frequently feed on marine mammals, and there are local population that are specialized in seal predation. Sea Lion Island shelters a small resident population of killer whales, observed September to March. We studied killer whale predation of elephant seals, and we assessed its impact on the seal demography. The distribution of killer whale sightings and predations in space and time, and the observed killer whale behaviour, shows that elephant seal hunting is probably the main reason for their presence at Sea Lion Island. However, the number of predation attempts and the success rate were lower than we expected. Although killer whales can predate on all sex and age classes, including large breeding males, their successful takes are not enough frequent to regulate the elephant seal number, and elephant seals are probably just a minor component of their diet.



www.eleseal.org