

# Long-term study of elephant seal reproduction shows population's resilience

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Researchers found that as the density of an elephant seal breeding colony increases, the size of the pups at weaning declines, and this effect is more pronounced for the pups of younger females. Credit: Dan Costa

A new study based on four decades of data from the elephant seal colony at Año Nuevo Reserve has enabled researchers to disentangle the effects of environmental conditions, population density, and maternal traits on reproductive success in northern elephant seals.

The study, published October 13 in *Proceedings of the Royal Society B*,

focused on how much the pups weighed when they were weaned (weaning mass), because higher weaning mass increases a pup's chance of survival. First author Rachel Holser, a postdoctoral researcher at UC Santa Cruz, said she expected major oceanographic events that affect the abundance and distribution of the seals' prey to have a big effect. To her surprise, however, other factors turned out to be much more important.

"The single most important factor in determining the weaning mass of pups was the age of the mother," Holser said. "That was more important than the mother's size, which is a measure of her foraging success, and certainly more important than conditions in the ocean. We expected major El Niño events and other oceanographic events to have more impact than they did."

The mother's age is important for several reasons, she noted. One is that older females produce milk with higher fat content at the start of lactation than young females do. But the mother's experience is also crucially important. A more experienced female is better able to choose and defend a good location on the beach for rearing her pup, and she is better able to keep her pup from getting lost and wasting its energy.

"When she gives birth to this tiny pup, it's got four weeks to put on as much fat as it can, which means it needs to spend as much time as possible nursing and resting," Holser said.

This gets harder as the population grows and more and more animals are crowded together on the beach. "When the colony becomes more dense, there are more interactions—sometimes the females are fighting, or the males will cause a disturbance—and pups end up getting lost and wasting energy trying to find their mother," she said.

The study found that higher [population densities](#) led to smaller pups overall, but this effect was more pronounced for younger females than

for the older, more experienced ones.

Holser noted that, while it is often assumed that a larger female will have larger pups, the mother's age is actually more important than her size.

"There's a lot of variability in size, and the data show that what's really important is the experience of having been through multiple reproductive cycles," she said.

Ocean conditions—such as El Niño events, the Pacific Decadal Oscillation, and marine heatwaves—do matter, she said, but their effects on weaning mass are relatively small compared to other factors. "It's not that it doesn't play a role, but it's not nearly as important as those onshore conditions—who your mother is and how dense the colony is," Holser said.

This resilience in the face of changing environmental conditions is largely due to the elephant seals' reproductive strategy. Female elephant seals spend months at sea traveling vast distances across the North Pacific Ocean to feed and put on weight before returning to the colony to give birth. While nursing their pup, they do not leave the beach to feed, relying on the stored energy acquired during the foraging migration.

Other species, such as the California sea lion, depend on regular feeding forays while they are nursing their pups, so a change in conditions that makes it harder to find prey off the coast can be disastrous.

"During a major El Niño, you can see almost complete reproductive failure in some years for species like sea lions," Holser said. "With elephant seals, we don't see that kind of boom and bust effect. Even in a poor year, they manage to be pretty successful."

She cautioned, however, that the effects of ocean conditions on elephant

seals can be seen in some measures of the population's health other than weaning mass. In bad years, some females will skip breeding entirely to restore their body condition rather than rearing a pup. There may also be a decrease in the survival rate of adult females.

"Previous work has shown that ocean conditions impact the ability of the mother to invest in her young, but this study shows that age and, more importantly, experience can compensate for those environmental changes," said coauthor Daniel Costa, professor of ecology and evolutionary biology and director of the Institute of Marine Sciences at UCSC. "As a senior scientist, it's good to know that experience matters!"

Northern elephant seals were hunted to near extinction by the early 1900s, but the population has made a remarkable recovery since the end of commercial sealing. Thousands of pups are now born every year at the breeding colony at Año Nuevo Reserve, part of the UC Natural Reserve System.

The long-running elephant seal research program at UC Santa Cruz has been studying this colony since the 1960s, yielding an invaluable trove of data. Begun by Professor Emeritus Burney Le Boeuf, the program has continued under Costa's leadership.

"This study was only possible because of the work of hundreds of people who have been taking these measurements for over 40 years," Holser said.

**More information:** Rachel R. Holser et al, Density-dependent effects on reproductive output in a capital breeding carnivore, the northern elephant seal ( *Mirounga angustirostris* ), *Proceedings of the Royal Society B: Biological Sciences* (2021). [DOI: 10.1098/rspb.2021.1258](https://doi.org/10.1098/rspb.2021.1258)

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