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High-tech tracking devices reveal new details of elephant seal migrations and feeding strategies

For Immediate Release

SANTA CRUZ, CA--Thousands of elephant seals are now returning from their fall migrations for the winter birthing and breeding season at Año Nuevo, a major rookery for seals and sea lions 55 miles south of San Francisco. How the elephant seals spent their months at sea, a question once shrouded in mystery, is becoming much clearer thanks to some sophisticated new tracking technologies deployed by scientists at the University of California, Santa Cruz. Among other things, the researchers have found striking differences between male and female elephant seals in their migration patterns and feeding strategies.

The research team, led by UCSC professors of biology Burney Le Boeuf and Dan Costa, has been studying the diving behavior and diving physiology of northern elephant seals since 1983. Other researchers--Dan Crocker, Susanna Blackwell, Paul Webb, and Dorian Houser--joined the team as UCSC graduate students and are now at other institutions.

The group's most recent findings come from tracking the daily movements of 47 elephant seals during the two foraging trips the animals make each year, spending months at a time at sea. Satellite tracking devices and data recorders attached to the 27 adult males and 20 adult females traced their migration routes and diving patterns with unprecedented accuracy. The results revealed several interesting features of elephant seal migrations, including the following:

- * Male and female elephant seals travel to different areas and feed on very different kinds of prey.
- * Male elephant seals show remarkable consistency in their migrations, following the same routes to the same places year after year.
- * Females follow more variable routes, apparently pursuing prey that move from place to place in the open ocean.

UCSC researchers deployed the first time-depth recorder on an elephant seal in 1983 and documented the seals' phenomenal diving abilities. Adult females, for example, can dive to depths of nearly 5,000 feet and can remain submerged for more than an hour.

"We were amazed at the results, which gave us our first insights into the animals' behavior at sea, but these recorders provided only information on what the animals did, not where they went or how they got there," Costa said. "Tracking the animals'

movements by satellite allows us to put their diving behavior in the context of where it occurs in the ocean."

The group's most recent results have not been published yet, but the researchers have presented their findings at various scientific meetings. In December, Le Boeuf and Crocker presented papers at the biennial meeting of the Marine Mammal Society in Hawaii.

Scientists have long known the general migration patterns of male and female elephant seals. Both sexes leave the rookery after the breeding season ends in March. The females depart first and return to molt in May, after which they head back out to sea on an eight-month foraging trip. The males are at sea for about four months in the spring, return to molt in mid-summer, then embark on another four-month foraging trip. The food the seals gather on these trips is crucial, because it must sustain them through long periods of fasting while they are on land.

"Fifteen years ago, we knew woefully little about the diving and foraging behavior of marine mammals," Le Boeuf said. "We knew the seals entered the sea to feed and returned at predictable times, but we knew nothing about what they did and how they did it. Technological advances in instrumentation, microcomputers, and satellite technology have changed all of that."

In their recent tracking studies, the researchers found that the males headed north and traveled directly to certain areas along the continental margin, ranging from coastal Oregon to the Aleutian Islands in western Alaska, almost 3,000 miles from Año Nuevo. The largest males tended to travel the greatest distances to their feeding grounds. Once a male reached its destination, it stayed there to feed before heading back to the rookery. Females, in contrast, ranged across a wide area of the northeastern Pacific, feeding in the deep waters of the open ocean and moving from place to place.

"The sexes are foraging for prey quite differently, and they have to because of the discrepancy in size between males and females," Le Boeuf said.

Male and female elephant seals are markedly different in size and appearance, a phenomenon known as sexual dimorphism. The adult males, with their extraordinary trunk-like noses, can weigh almost 3 tons and are three to seven times larger than mature females.

In several cases, the researchers were able to track the same animal during more than one migration and found that they tended to follow the same route every time. The males, in particular, were remarkably consistent, traveling identical routes to and from the same feeding grounds year after year. Females tended to start out in the same direction each time, but ended up following different routes on successive trips.

"The males seem to be going to a fixed place to feed, whereas the females are feeding on patchily distributed prey that shift around from place to place," Le Boeuf said.

Diving profiles also indicated different feeding behaviors in the two sexes. The predominantly flat-bottomed dives of the males suggest a descent to the seafloor to feed on bottom-dwelling prey, such as skates, rays, rattfish, small sharks, and hagfish. The females' jagged-bottomed dives suggest they were pursuing prey that moved up and down in the water column with available light, primarily several species of squids.

Male elephant seals gain substantially more weight during these foraging trips than the females do, despite spending less time at sea feeding. They may be finding more food, eating higher-quality food, or both, Le Boeuf said. Putting on weight is of critical importance to male elephant seals, because a male's size largely determines his ability to win fights with other males, and his dominance status is directly related to success in mating with females. A dominant male is able to control a large harem of females, mating with them exclusively and keeping all other males away.

This reproductive system, known as polygyny, is the evolutionary force driving the sexual dimorphism and divergent foraging strategies in elephant seals, Le Boeuf said. Because the largest males father most of the pups, natural selection has favored larger and larger males with correspondingly high energy requirements.

The males expose themselves to additional risks, however, in foraging along the continental margin. Killer whales and white sharks are known to prey on elephant seals along the coast and around the Aleutian Islands, while the females are less likely to encounter such predators in the open ocean. Thus, the males migrate longer distances and take more risks than the females, but it pays off for the survivors in terms of foraging success and, ultimately, reproductive success.

The females' foraging strategy is not without its vulnerabilities, however, as was demonstrated during the 1997-98 El Niño season. El Niño brings unusually warm waters into the northern Pacific and significantly alters the distribution of fish species, including squid. In 1998, females tracked by the researchers spent more time looking for patches of food and less time feeding in any one location than in normal years, said Crocker, now at Sonoma State University. The result was that the females did not gain as much weight as usual, which could significantly affect their breeding success.

UCSC researchers are using similar tracking technologies to study a variety of marine mammals. "We are able to monitor continuously the diving pattern of a seal, sea lion, or whale in minute detail for up to a year at sea, and we are learning unexpected things," Le Boeuf said. "Ironically, we now know more about behavior at sea than about some behaviors on land."

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Notes to reporters and editors: Reporters may contact Le Boeuf at (831) 459-2845 or leboeuf@cats.ucsc.edu, and Costa at (831) 459-2786 or costa@biology.ucsc.edu.

Images can be downloaded from the Web at http://www.ucsc.edu/news_events/download/. This release is available electronically at <http://press.ucsc.edu>.

During the winter breeding season, Año Nuevo State Reserve offers guided walks for the public to view the elephant seals. For information, contact the reserve at (650) 879-2025, or (650) 879-0227 for recorded information. The reserve's web site is <http://www.anonuevo.org>.