

**Ano Nuevo Research Night**  
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### **Introduction**

Dan noted that he had recently spent time in Antarctica with southern elephant seals and will discuss later in the presentation.

Dan started his early research career with sea otters when at Scripps, but went to elephant seals in 1975, UCSC. His initial interest was in the physiology of elephant seals, but he has more recently moved to habitat studies. What is habitat in the ocean? The place where animals live, the structure of the ocean. On land, habitat is deserts, rain forests, tundra, etc.

### **Research Equipment**

First instrument on an elephant seal was a time/depth recorder in 1983 that recorded 2 weeks of data on a special film. Later Dan realized it was film similar to that used in spy satellites of the era. (First instrument on a marine mammal was Weddell seals in Antarctica, 1978.)

Current instrument technology is satellite linked and can be read on his office computer. Instrument measures temperature and salinity along with track link and costs \$7,000. Temperature and salinity typically define the habitat(s) of the ocean.

### **Female Elephant Seal Distribution**

Slides showed female ES track distribution over the four calendar seasons with 100 to 150 animals. Post breeding showed short trips to allow their return for catastrophic molt. After molt, their primary distribution in open ocean was along a band between 40°N - 50°N latitude, with some exceptions. (Response to Question (RTQ): Females are mostly tagged because males tend to go to solid features and not to open ocean. Also males are not as likely to return, and they are more difficult to instrument.) Females from the Channel Islands and from Mexico tend to travel north up the coast and turn out into the same open ocean band area for foraging. Males from Mexico tend to forage the slope of the continental shelf from Mexico to southern Alaska, but not out to the Aleutians Islands like Ano Nuevo males.

Female have an average 6-7 pups lifetime

### **Seal Foraging Habits and Patterns**

The continental shelf is a dangerous place for elephant seals - lots of predators. The ideal breeding locations are where the shelf is narrow and deep water is close by.

The female foraging band area happens to be along a current boundary where there is a major temperature change in the waters. This is the interface of the Alaska and the Pacific currents, with the females positioned in the colder, sub-Arctic side of the current split. The band of currents moves north and south seasonally. The interface band of currents creates major eddies (cyclones) that pull up nutrients from the deep. Also, cold water that hits the Alaska coast creates eddies where elephant seals focus. The coastal eddies pick up nutrients from the continental shelf, then move off shore with sea life. From other studies, it is apparent that other sea life focus on the current band. Elephant seals may be competing with orcas, sharks, albatross, etc, but they have the advantage of feeding at depth.

ES female foraging tracks were studied by age groups (annual variations may impact):

- 3-6 yrs --- all over the map
- 7-9 yrs (optimum age) --- focused on the between currents band!
- 10+ yrs --- surprise that some wandered along the coast

Loose interpretation, youngsters are trying to find the spot, middle age are physiologically in best shape for oxygen stores and better divers, and older and more experienced females are more efficient in their foraging. One female did very well foraging the eddies along the southern coast of Alaska. Researcher tagged females and showed post molt that they typically move into the same area or pattern, independent of weight gain. By chance, a female was tagged in 1995 at 6 years and again in 2006 at 17 years and noted that she followed the same foraging track into the open ocean. Possible they are statistically staying with what has been successful, lean years and good years.

Northern ES – 85% feed offshore beyond the shelf

Mexican NES smaller than ours- because they spend an extra month in transit

Migratory route – evidence of map sense. They take the Great Circle route. Can follow noise, e.g. the crashing waves on the shoreline. Magnetic fields can be used for navigation. They can follow a magnetic trajectory.

### **Male Elephant Seals**

It has been noticed that annually, male elephant seals repeat the same track traveling to the Aleutians, (but varies with the following trip(?)). Males feed along the continental shelf, actually on the slope, not up on the shelf, which is only 200 meters deep. In transit to foraging areas, males are opportunistic feeders. Theoretically, a male ES could go 5 months without feeding, including beach time for breeding and transit. Mexico animals are not as large as Ano; spend extra time (one month) in transit to foraging areas. Point Reyes is furthest north point known for breeding, though an incipient ES colony has been seen on Vancouver Island; maybe not breeding, but molting.

Male feeding strategy – by age 5-6 tend to feed on edge of continental shelf – not over it (cont. shelf is only 200 meters max depth in CA) .

Only 1 in 10 males will breed. Most males begin breeding at age 9

### **Seal Navigation**

How do elephant seals navigate? Researchers used special plot and found that they use the great circle route to their destination. Need a map sense for shortest direction on migratory route, thus not just following a bearing. Plot of paths for females returning to Ano show that they hit the continental shelf, then work their way up to Ano. How do they navigate up the coast? Possibilities:

- crashing waves
- visual clues (but fog had no effect)
- acoustic land bounce
- geomagnetic intensity (birds and turtles use)

Females can migrate out as far as the International Date Line! Elephant seals have been seen hauling out on Vancouver Island.

All weaners tend to follow male pattern until at least 4 yrs old.

### **Diving**

Northern E seals have an average 20-24 min dive length. Average 60 dives per day

Female dive patterns --- found processing (digestion) dive after foraging. Females in third trimester no longer sink on dive, but float back up due to putting on fat. Dive speed is between 1.5 - 1.75 m/sec (3 - 5 mph). Swim speed at depth is 1 m/sec or 2 mph. Deepest recorded ES dive was female at 1650 meters or 5,413 feet. Only beaked whale and sperm whale are deeper divers among mammals. Elephant seals are very efficient breathers when they are on the surface, using their total lung capacity where typically humans use only in a range of 30%. Elephant seals have only one lung lobe, not branches like humans or dogs/cats/sea lions. They can breathe quickly and deeply without their lungs collapsing because their lungs are reinforced (with fibers).

Other factors that contribute to dive capabilities --- blood volume is 3X human; 22% ES by body weight versus 7% human. And 65% of blood is hemoglobin.

Their heart rate at the surface is 120/sec, but drops to 40 - 50 /sec on the dive and under 10/sec on deep dives. Oxygen concentration in the blood at the start of a dive is 50 mm Hg and drops to 3 mm Hg when they resurface. It is possible that a low oxygen concentration on a dive triggers resurfacing. The lowest recorded rate on a dive is 4 beats per minute.

Sleep (REM) only occurs when they are holding their breath (apnea) on land or on an ocean dive.

Maximum dive time – 119 minutes. Beaked and Sperm whales can dive deeper than NES.

Dive pressure – for every 10 meters (33 feet), add 1 atmosphere pressure – so 600 meters depth = 60X pressure found at surface

ES have single lobe lungs – not multi-lobed lungs like humans and other animals, and have reinforcing structures in their lungs.

### **Southern Elephant Seals**

Comparison of northern and southern female elephant seal foraging --- northern seals spend 85% of their time off shore, while southern only spend 14%. This may be due to the fact that the southern continental shelf, especially around Antarctica, is much deeper. Interesting that southern elephant seals have been used to plot the ocean bottom under the Antarctic ice shelf. A plot of dive routes identified deep canyons as primary routes into shallower areas. These canyons were also responsible for deep water currents (which are a few degrees warmer than surface waters, feeding up under the ice shelf. This information helped atmospheric scientists identify the additional heat balance requirement for recent break off of a major section of the ice shelf.

Antarctica has a very extensive continental shelf and is much deeper and erratic. The shortest distance at sea is defined by the “great circle loop”. The seals are using the great circle loop in their transits, so they must have some sort of map sense.

SES - mean dive 345 meters max dive deeper than NES – 2100 meters