Foraging Behavior of the Female Northern Elephant Seal

From the days less than 25 years ago when we thought elephant seals only migrated north along the coast, to the pink and blue diagrams we used to carry in our packs, to the tracking diagrams we use now, a lot has been learned about migration. As we increase our knowledge of where the seals go, we are better able to understand how the elephant seal operates in its environment. While the size and cost of the tracking and recording devices are going down, the amount and types of data that can be recorded are increasing. The main purpose of this paper is to refine our knowledge of the female elephant seal migration. One of those refinements has to do with the diet of elephant seals and is introduced at the end.

In a study done over six years (2004 – 2010), primarily at Año Nuevo, 297 migrations of **adult female elephant seals** were studied. Some seals were tracked for more than one migration. Seals were tracked both on the short, post-breeding (133) and the long, post-molting (144) migrations. Not all the migrations were completely recorded. The authors based most of their report on the 184 completely recorded migrations. Figure 1 shows the tracks of these seals, including 20 from Islas San Benito, Mexico (ISB).

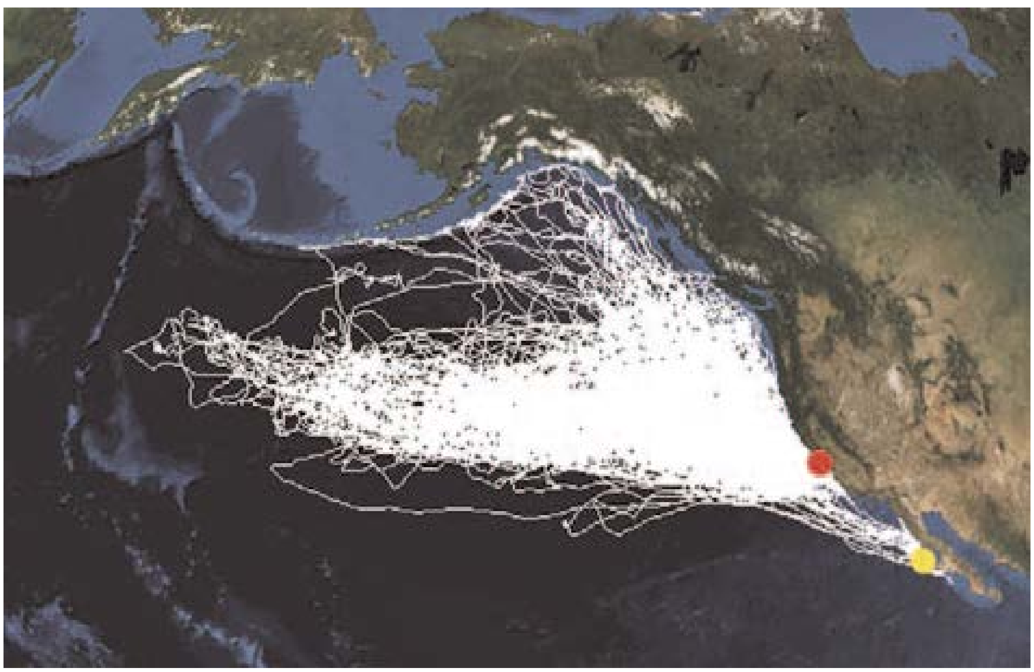


Figure 1. The red dot is Año Nuevo, the yellow is Islas San Benito.

With the early studies we had to be careful because the numbers of seals tracked was so small that we weren't sure if our samples were representative. This study involved a large number of seals; the amount of data is truly astounding.

Just the 184 complete migrations comprised:

25,000 seal days at sea,
788,000 horizontal miles of travel,
896,000 vertical miles of dives,
1,404,000 dives and
1,200,000 temperature profiles.

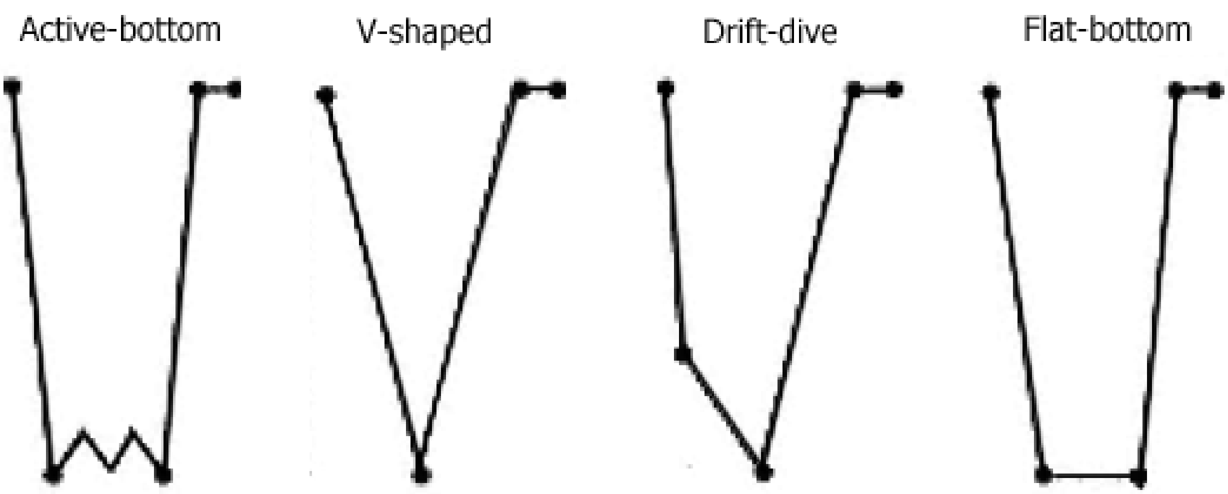
In general the results of this study agree with previous studies. The authors found:

91% of the seal's time at sea was spent in dives.
Dives varied in duration from 2.6 to 109 minutes and averaged 23 minutes.
Daytime dives were significantly deeper (2030 feet) than nighttime dives (1500 feet).
Once in the feeding areas the average daily weight gain was the same for the short and long migrations (2.2 pounds per day).
Only 5% of these seals returned to a different rookery.

While the depth of the dives remained the same, the duration of dives was longer on the long migration. The seals seemed to get better at staying under as their time at sea increased.

The authors classified each dive into one of four types and reported the percentages observed of each:

Active-bottom	Ocean foraging – 54%.
V-shaped	Transit – 31%.
Drift dives	Food processing & rest – 10%.
Flat-bottom	Ocean bottom foraging – 6%.



In broad strokes, each migration had two components: travel to and from the foraging areas, and travel within the foraging area. The diving behavior was distinctly different in these two situations. While in transit the seals primarily used V-shaped dives. Their horizontal speed was greater than when they were in the foraging areas. It seemed that the seals would feed if they came across prey, but their main goal seemed to be distance. As the seals reached the foraging areas their dives changed. The majority of dives were active-bottom dives. These dives are interpreted as the seals diving to a depth at which they expect to find food and then moving up and down in the water as they pursue and consume prey. Interspersed among the active-bottom dives were drift dives which are interpreted as digestion and rest dives. The flat-bottom dives were mainly performed by the seals which went further north to the Aleutian Island feeding area (Figure 2). There the ocean is shallower and the seals seemed to search along the bottom for prey.

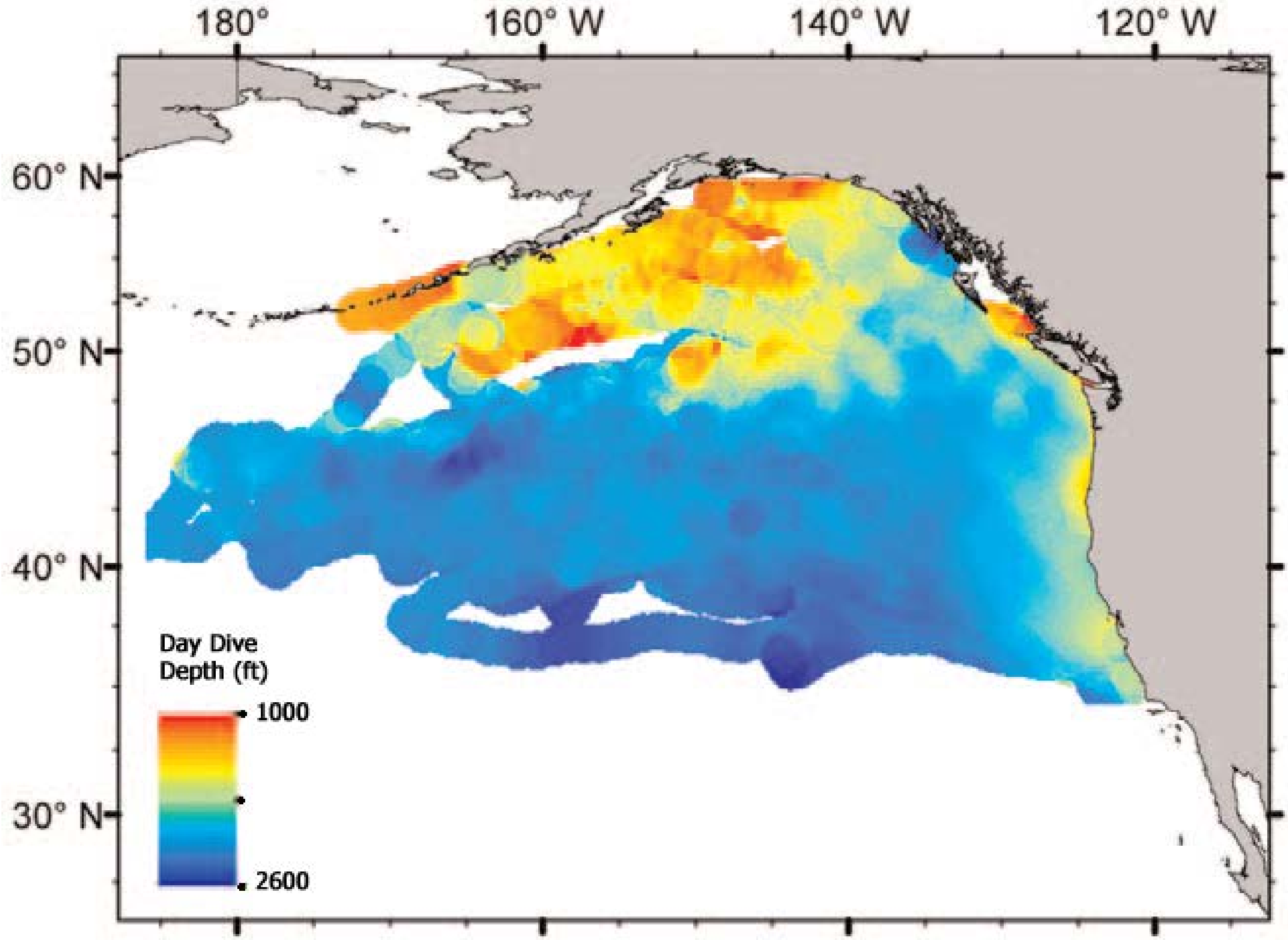


Figure 2.

By plotting the short and long migrations separately we can get a much clearer picture of where the seals go and what they do. Figure 3 shows that the longer time available on the long migration allows the seals to travel further west, and for some of the females to travel further north.

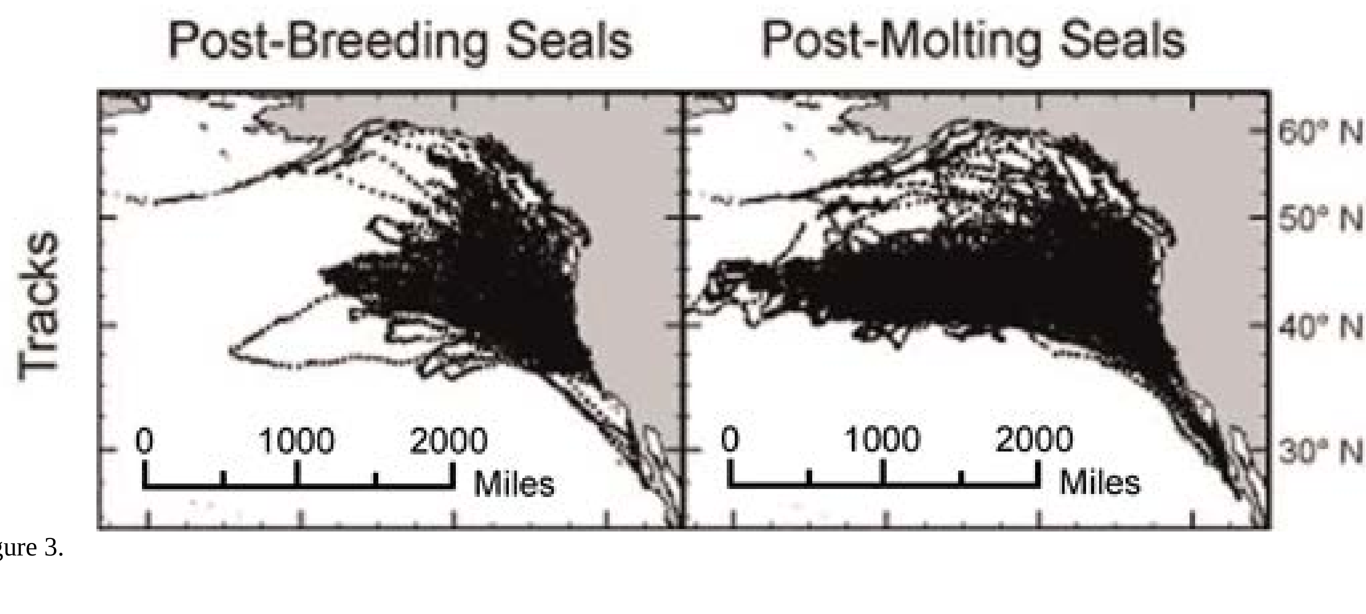


Figure 3.

Figure 4 shows how fast the seals are traveling. The gray areas show that when the seals are leaving or returning to the rookery they are moving relatively rapidly and not doing much feeding. (The rate of travel in the gray areas averages 60 to 75 miles per day.) In the orange areas the seals are not covering much horizontal distance. The interpretation is that the seals are finding food and not traveling much.

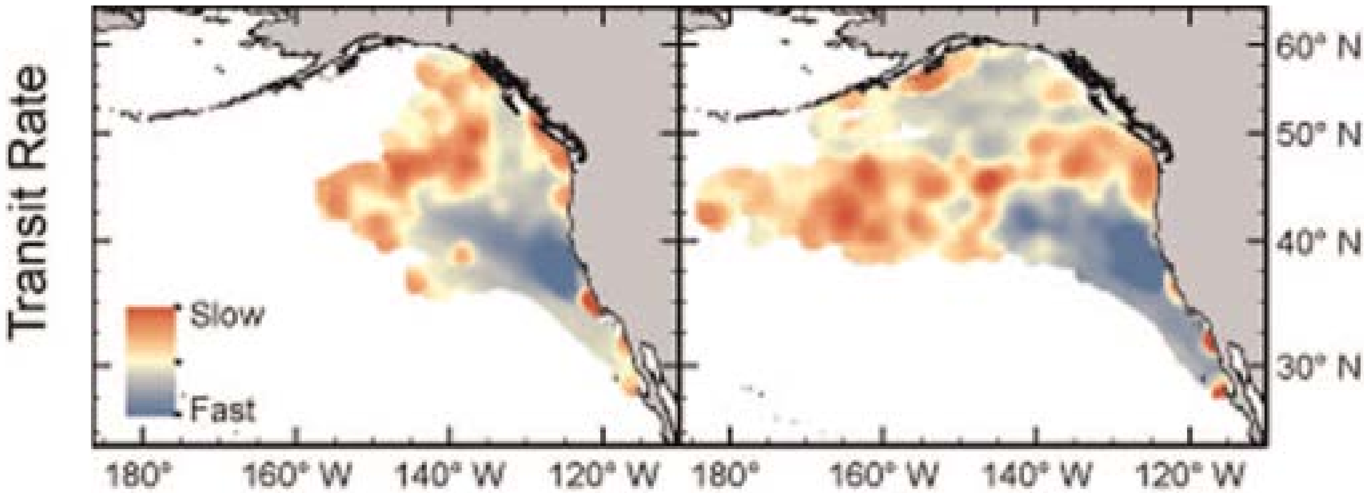


Figure 4. Post breeding and post molting transit rates.

Figure 5 is in complete agreement with the hypothesis that this is where seals are feeding.

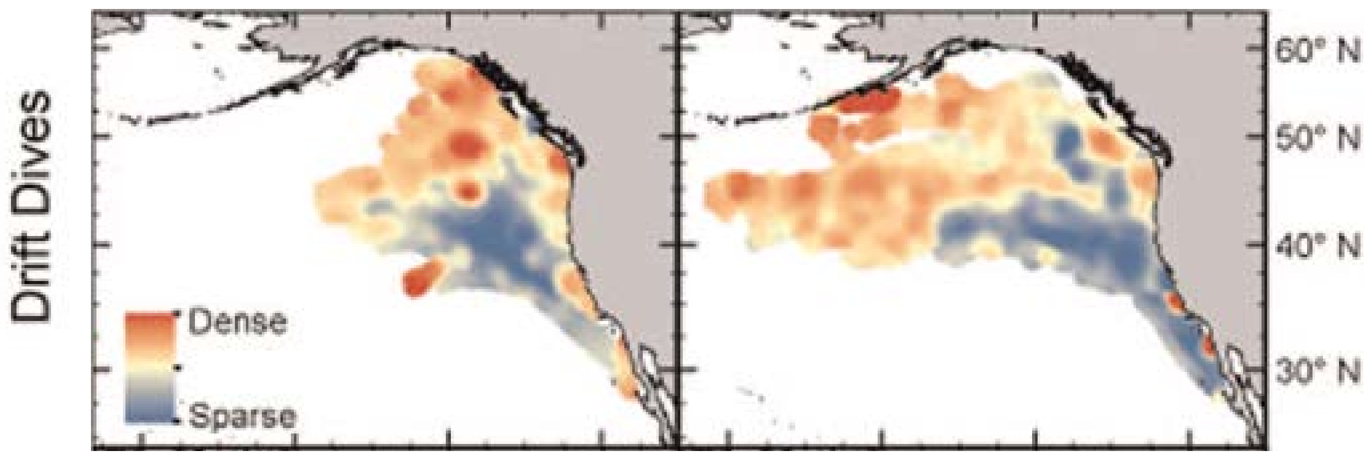


Figure 5. These graphs of the short and long migrations show where the density of drift dives (food processing and rest) is the greatest.

To draw some conclusions about the distances the seals travel, 20 seals whose rookery is on Islas San Benito, Mexico, 700 miles southeast of Año Nuevo, were tagged during the 2005 long migration and the 2006 short migration. In general the diving and tracking data did not differ from the Año Nuevo seals. However if was found that while only 4% of the Año Nuevo seals foraged exclusively within 300 miles of their rookery, 20% of the ISB seals foraged exclusively that close to their rookery. To quote the authors, “We found a mix of strategies in which most Islas San Benito seals traveled north to feed in the same areas as those from Año Nuevo while a subset of the population remained local.”

It is very informative to compare the foraging of elephant seals with what we know of ocean currents in the area. (Figure 6) This map shows two major gyres in the northeast Pacific. When Figure 6 is compared to Figures 3, 4 and 5, it is clear that the gyre boundary is the area where female elephant seals forage the most.

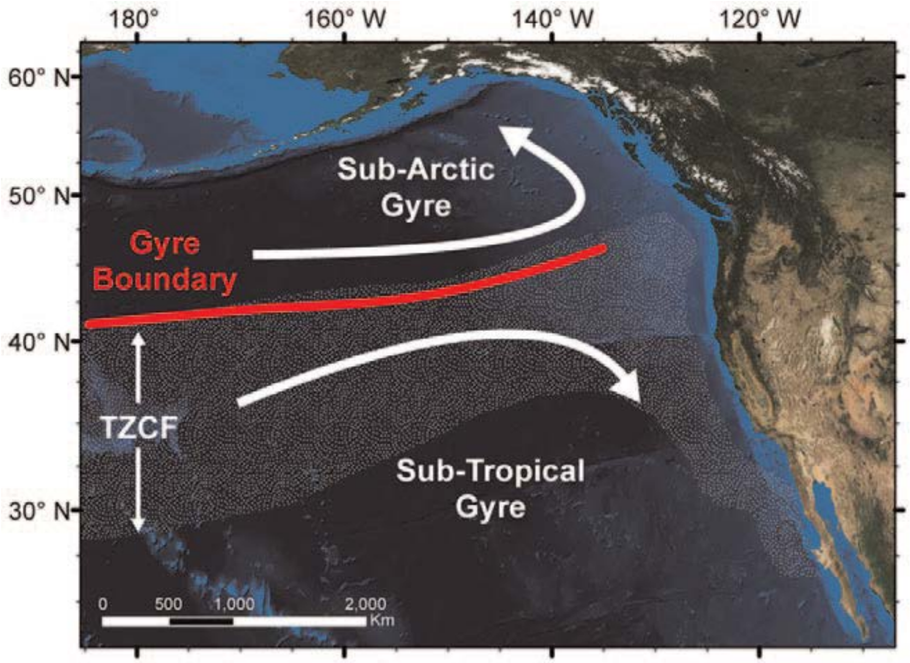


Figure 6.

In Fig. 6 the light gray area is labeled as the Transition Zone Chlorophyll Front (TZCF). This area of high chlorophyll production is easily seen in satellite data. While there seems to be some relationship to the use of this area by the top predators, for elephant seals it seems to be the gyre boundary that is significant and not the TZCF. In Fig. 7, the more orange the color, the greater the density of seals.. The gyre boundary (black line) is an area of intense feeding for female elephant seals

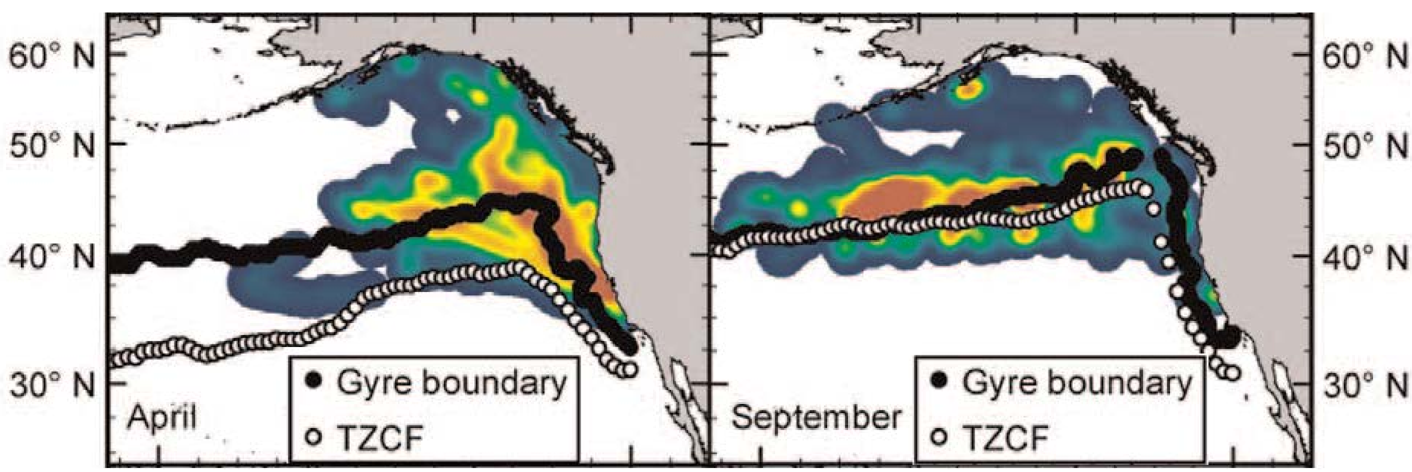


Figure 7.

At least three migration strategies are illustrated in this study: to the gyre boundary area, north to Alaska, and local feeding. Although individual seals have just one migration strategy, as a group, this mix of strategies bodes well for the success of the species.

This study found a birth rate of 84% based on 120 Año Nuevo females. Of the seals in this sample that failed to reproduce, almost all returned from the long migration well before or well after the main birthing and breeding months of January and February. Because researchers studying birth rates by making observations on the beach during the birthing season would miss these seals, the authors suspect that birth rates reported by other studies may be biased high. It is worth noting that compared to other large mammals; a birth rate of 84% is high.

This study confirms previous work and adds more information about the environment in which the adult female elephant seal operates. In addition the authors introduce a possible new food source.

Something to watch for.

There are so many ocean species that move closer to the surface at night that they show up on sonar scans. This is referred to as the deep scattering layer. Elephant seal dives often follow a diel (daily) pattern in which they dive deeper during the day and shallower at night. In many cases this follows the pattern of prey species such as squid and the deep scattering layer. However, often the elephant seal dives deeper than this layer; they seem to be going after a different prey. One of the most abundant species of fish in the oceans is lanternfish. They are small, ranging mostly from 1 to 6 inches, and are bioluminescent. Some of these fish do not follow the diel pattern of the deep scattering layer, and may be what the seals are going for when they go deeper than the layer. The authors comment, "… the elephant seals are exploiting a resource that has not been adequately characterized". Another study by some of same authors investigates this further. (Yasuhiko Naito, Daniel P. Costa, el al, (2013) Unravelling the mysteries of a mesopelagic diet: a large apex predator specializes on small prey.) These authors feel that e-seals that hunt for bioluminescence or swim vortices that they detect with their whiskers are less efficient than toothed whales that hunt the same prey using sonar. This might help explain why e-seals spend so much time diving.

Figure 8. Lanternfish.

It also causes me to think that the cookie cutter shark, which attracts prey by mimicking the appearance of small fish, may also attract e-seals in this way

All figures are adapted from the article except the dive-type diagram, which is adapted from LeBoeuf, and the lanternfish from the internet..

Robinson PW, Costa DP, Crocker DE, Gallo-Reynoso JP, Champagne CD, et al. (2012) Foraging Behavior and Success of a Mesopelagic Predator in the Northeast Pacific Ocean: Insights from a Data-Rich Species, the Northern Elephant Seal. PLoS ONE 7(5): e36728. doi:10.1371/journal.pone.0036728