AMONG FRIENDS

Friends of the Elephant Seal Member Newsletter

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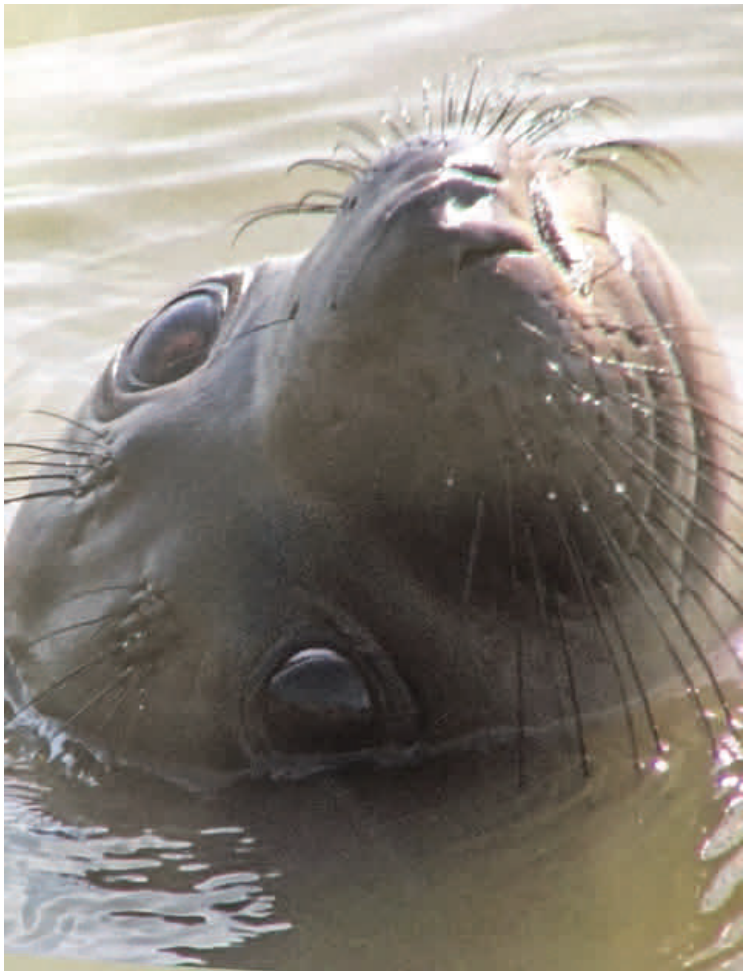
Fall 2017

A Breath of Fresh Air

Between each dive, an elephant seal comes to the surface for 1 - 3 minutes to breathe. What must be accomplished during this brief period?



The respiration and blood circulation of land mammals are quite different from those of marine mammals. For a land mammal, breathing regularly is the normal condition with the circulatory system serving as a "conveyer belt" between lungs and organs. For a human, as an example, the oxygen concentration in the arteries, carried in hemoglobin in the red blood cells, is usually near 100%. Since the concentration in the veins is around 70%, there is some storage capacity in the system but that is limited because the organs can function well only with reasonably high oxygen concentration in the blood.

By contrast, for marine mammals, not breathing for extended periods is the norm so that the circulatory system is of vital im-

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The California Sea Lion

Visitors to the Piedras Blancas rookery can sometimes hear the distant sounds of barking—very different from the normal trumpeting of male elephant seals. It's California sea lions who are frequent visitors to the wedge shaped rock opposite the elephant seal viewing area. California sea lions are the most well-known and easily recognized of the five species of sea lions worldwide. Their intelligence, playfulness and ability to be trained make them very popular in zoos, circuses and aquariums. The United States Navy has used them for various undersea operations. California sea lions often can be seen hauled out on boats, wharves, docks and buoys.

Male and female California sea lions differ in size, shape and coloration. Males can weigh between 700 and 880 pounds while females are usually no more than 240 pounds. Both have solid color coats. Females and juveniles tend to have lighter golden brown coats while large males' coats typically are chocolate brown with a light tan area on the face. They all have a slender build, long narrow muzzles and tiny external ears. The males have robust necks, chests and shoulders and, around age five, develop a sagittal crest on the top of their heads.

The sea lions, like the elephant seals, are pinnipeds or seals. But while the elephant seals use their rear flippers to swim, the sea lions use their long front flippers to propel themselves in the ocean while gliding between strokes. Their spines are so flexible they can bend their head backward far enough to reach their hind flippers enabling them to make sharp turns while maintaining a streamlined body. On land, sea lions can rotate their hind flippers under their pelvic girdles and use them as legs to aid in walking. When moving they swing their heads and necks to create momentum and this rather than the hind flippers provides much of their locomotion.

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A Breath of Fresh Air *(Continued from page 1)*

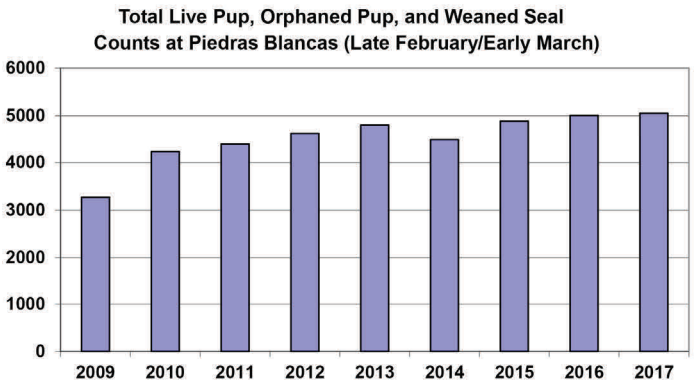
portance for oxygen storage. For the northern elephant seal, oxygen concentration in the arteries drops to as low as 8% by the end of a dive and the concentration in the veins as low as 1%. Elephant seals have three times the volume of blood per pound of body weight as a human and that blood has twice the density of hemoglobin. Oxygen storage in the blood is supplemented by oxygen storage in myoglobin in the muscle, at 15 times the density in human muscle, increasing total oxygen storage by about 35%. The total storage capacity per pound of body weight is therefore around eight times that of a human.

Prior to the next dive, the seal must recharge the oxygen level of both hemoglobin and myoglobin and expel the accumulated carbon dioxide. This recharge process actually begins shortly before surfacing and continues into the first minute or so of the next dive. As the seal ascends to the surface, circulation of blood to the muscle resumes, beginning the recharge of the myoglobin with the remaining blood oxygen. On surfacing, breathing resumes, heart rate triples, the lungs expand, and full peripheral circulation is restored. The seal will breathe 30 to 40 times and then dive, ceasing peripheral circulation and breathing and reducing heart rate. The oxygen in the lungs at the start of the dive contains less than 5% of the oxygen in the body at that time but that is quickly absorbed, boosting the oxygen concentration in the arteries to a peak early in the dive. The lungs collapse shortly thereafter and the seal continues, usually for 10 to 30 minutes but as long as two hours, on that reserve.

Jessica U. Meir, *et al.,* Extreme hypoxemic tolerance and blood oxygen depletion in diving elephant seals. *Am J Physiol, 2009.*

The 2017 Pup Count

In spite of a reduced number of births, 5,600 this year versus 5,700 last year, the rookery set a new record of 5,050 surviving pups because of a slightly reduced mortality rate. The beaches have not recovered from their erosion losses over the past two years, resulting in crowding and mortality rates higher than normal.



The California Sea Lion *(Continued from page 1)*

The California sea lions' natural habitat ranges from Vancouver Island, British Columbia to the southern tip of Baja California. They forage near mainland coastlines, on the continental shelf or off seamounts – areas with upwelling. Breeding females normally stay near the breeding grounds (Channel Islands or Baja California) while the males and juveniles head north to feed. They travel both alone and in groups. They can stay at sea for as long as two weeks continuously diving and then resting on the surface. They typically dive to between 80 to 300 feet and stay down less than 3 minutes but have been known to dive to over 900 feet and to be under for up to 12 minutes. California sea lions eat a variety of prey including squid, octopus, anchovies, sardines, salmon, mackerel, hake and rockfish. They are preyed on by mako and white sharks and killer whales.

Female California sea lions have an 11 month reproductive cycle with 8 months of actual gestation and 3 months during which implantation of the fertilized egg is delayed. Birthing occurs between May and July. The Marine Mammal Center has been studying the Channel Islands' California sea lions for over three decades. According to the Director of Veterinary Science, Dr Shawn Johnson, most California sea lions give birth within a two-week period in mid-June. In fact over half the pups are born on June 15. The new pups weigh between 13 and 20 lbs. The mothers bond with their pup by smell and sound. Mothers spend the first week after the birth nursing their pups. They then will be out foraging for two to three days after which they'll return for around two days to care for their pup. As the pup grows the trip intervals become longer. Pups left on shore tend to group together to play and socialize. Mothers normally nurse for a minimum of five to six months but it can go on for over a year. The pups start eating fish at about two months of age.

About three to four weeks after giving birth the females will be in heat or estrus and ready to mate. The large males who arrived at the rookery in May have competed for land and those who did well have claimed territory. Normally they won't be able to successfully compete for territory until they are full size and around 10 years of age. Males usually can guard and hold their territory for only about two weeks al-though some have managed for as long as 45 days. During this time they are fasting so how long an individual sea lion can stay in charge is highly dependent upon his fat resources and the actions of other competitive males. And, although he's in charge of the territory, the females can freely move between male territories without experiencing coercion. It's his job to attract the females since females decide with whom they wish to mate. It's females who initiate courtship and copulation by displaying a submissive posture in front of the male. And, the female terminates sex by raising her head and shoulders and biting the male's neck. A male with an established territory will mate an average of 16 females in a season.

California sea lions can live for 15 to 25 years.

Staying Warm – Staying Cool

Mammals, regardless of their environment, generally keep their internal temperature in a narrow range. Many animals that live in cold environments have developed a counter current heat exchange system that entwines arteries and veins near the surface so the blood in the outgoing arteries transfers its heat to the returning cold venous blood, rather than loosing that heat to the environment.

For northern elephant seals (NES), in cases of high activity, their blubber insulates so well that they would become overheated except for a second system of heat regulation, shunts that can open to allow large quantities of arterial blood to flow near the skin, dumping heat to the ocean and returning cooled blood to the body core. Removing excess heat helps to maintain a constant internal temperature. Because the ocean absorbs heat so readily, this is an easy, low energy solution to overheating at sea.

This same system is used on land, but is just one of several ways the seals regulate temperature when ashore. Infrared photographs, or thermograms, show that on warm days the seals often flood portions of their skin with blood, especially near the rear flippers, releasing body heat to the cooler air. (Fig 1) The seals suffuse different portions of their thorax at different times so the thermograms show "hot spots" or thermal windows in various locations. (Fig 2)

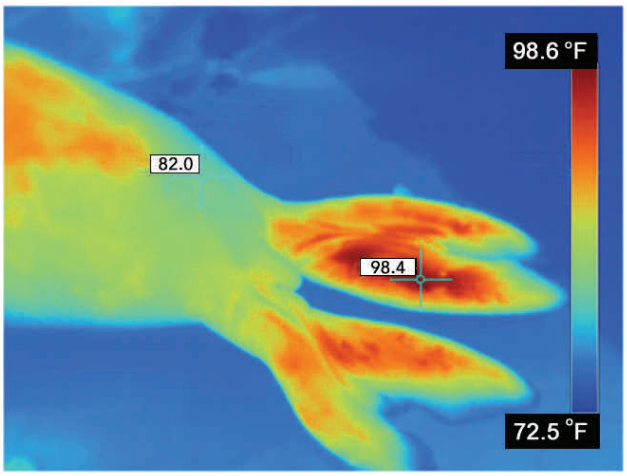


Figure 1. This thermogram illustrates rear flippers radiating heat

"Normal" body temperature for NES is around 99 degrees. Like the camel, another large mammal that is exposed to extreme temperatures, the NES can allow its core body temperature to vary by as much as 12 degrees. For one small group of mostly young NES a range of body temperatures of 18 degrees (from 87 to 105 degrees) was observed. An advantage of this ability is that a higher body temperature caused by daytime heat will keep the animal warmer into the cool evening and it won't have to burn as much blubber to stay warm. Similarly, by allowing the overnight body temperature to be low, it can get farther into the day before heat becomes a problem.

Being less active at night, and always wanting to keep energy consumption low, the seals tend to pile together, reducing the body surface that is exposed to the cooler air. The faster the day warms, the faster the pile breaks up, with most of them moving to the cool sand at waters edge.

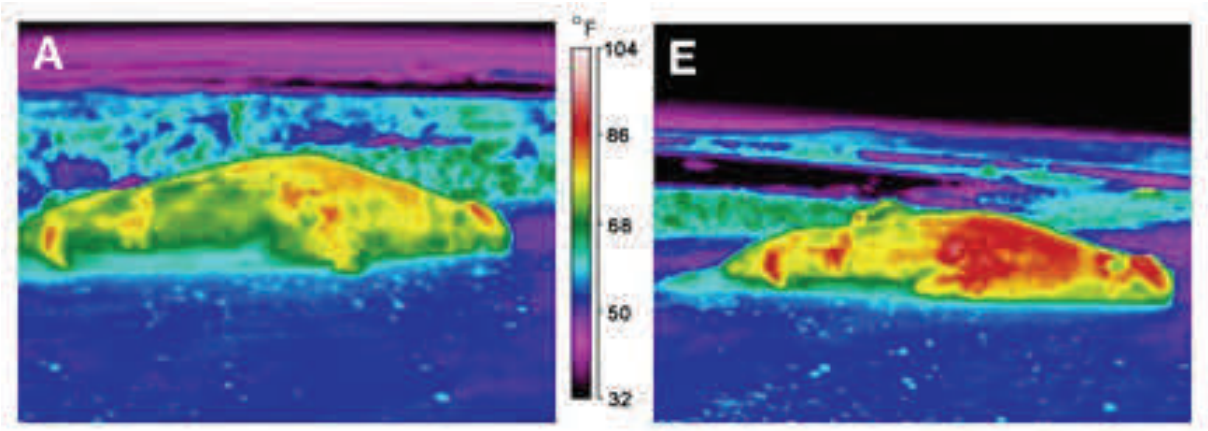


Figure 2. Thermograms A and E were taken 1 and 5 minutes, respectively, after an eleven minute fight with another bull. At minute 1, the cooling process is just getting started, by minute 5, much of the skin is nearly at core body temperature.

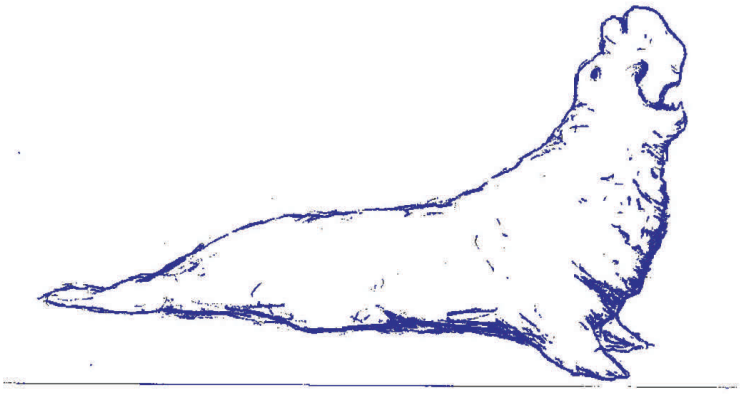
Sand flipping has a role here also. One study showed that skin temperatures under a layer of sand averaged about 9 degrees cooler than exposed skin. NES do have sweat glands, but they are few and far between compared to terrestrial mammals, and given the need to conserve water, they are probably used as a last resort.

With the tension between activity and the insulating qualities of blubber, when it comes to regulating body temperature it is easier for the seals to stay warm in the ocean than to stay cool on land.

Figure 1 adapted from: *Skin histology and its role in heat dissipation in three pinniped species* Wael A Khamas, Hrvoje Smodlaka1, Jessica Leach-Robinson1 and Lauren Palmer (2012)

Figure 2 adapted from: *Environment and activity affect skin temperature in breeding adult male elephant seals (Mirounga angustirostris),* A. L. Norris, D. S. Houser and D. E. Crocker (2010)

Friends of the Elephant Seal
Post Office Box 490
Cambria, California 93428



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Volunteer Training Dates

Basic Training in San Simeon:
Saturday , September 9, 2017

Advanced Training in San Simeon:
Saturday, September 23, 2017
Saturday, October 7, 2017
Saturday, October 21, 2017

Calendar

January **-** Females continue to arrive. Peak of births usually occurs during the last half of month.

February **-** Births end early in the month. The peak of mating is around Valentine's Day. Females begin leaving.

March - Last adults leave. Weaned pups teach themselves how to swim.

April **-** Females and juveniles return to molt.

May **-** Females and juveniles molt.

June - Subadult males return to molt.

July - Subadult and adult males molt.

August - Last of males molt.

September and October **-** Young-of-the-year and juveniles haul out to rest.

November - Juveniles joined by subadult males. Mature males begin arriving at the end of the month.

December - Bulls continue to return. Females arrive. The first birth is usually mid-month.

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www.elephantseal.org

Mailing Address
P.O. Box 490
Cambria, CA 93428
Email: fes@elephantseal.org
Phone: 805-924-1628