MIROUNGA, MIROUNGA

FOR THE TEACHER

Discipline
Biology

Themes
Evolution, Systems & Interactions

Key Concept
Elephant seals have many special adaptations acquired over millions of years of evolution, which help them to be extremely successful in both marine and terrestrial environments.

Synopsis
Students work cooperatively to teach each other about parts of the elephant seal life cycle and adaptations to contend with both the marine and terrestrial environments and then participate in a "game show" to check for understanding.

SCIENCE PROCESS SKILLS:
communicating, comparing, organizing, inferring

SOCIAL SKILLS:
encouraging, checking for understanding

VOCABULARY

Adaptation	copulate	delayed implantation
dominance hierarchy	fast	harem
Physiology	thermoregulation	wean

MATERIALS
For INTO the activities:
elephant seal visuals including some of the following:
slide show available from *MARE* library, videotape, pictures, postcards, posters, models, puppets and/or books
poster paper
colored markers

For THROUGH the activities:
Elephant Seal Information Cards *(1 set of either Adaptation or Life Cycle cards for every group of 5-6 students)*
copies of information "bits" cut out and glued onto 3 x 5 cards OR onto pictures, postcards, or student drawings graphically representing the information "bits"
poster paper, paper for class book
colored markers
numbered (1-6) slips of paper

INTRODUCTION
Elephant seals are marine mammals that spend much of their lives in or near the sea-dependent on the sea for food and the land for reproduction. The seals that come to Ano Nuevo Island every year are northern elephant seals, the largest of all Northern Hemisphere seals and only surpassed in size by the Southern Hemisphere elephant seal. An adult male may be 15-16 feet long and weigh as much as two tons. Elephant seals were given their common name because of their great size and also because of the trunk-like snout or proboscis on the heads of the males. The scientific name of the northern species is Mirounga angustirostris.

In the 1800s, Northern elephant seals were hunted so relentlessly that they almost became extinct. The big seals were sought for the six inches of blubber under their skins. Like whales, elephant seals were killed and their blubber was stripped off and rendered into oil. Seal oil was burned in lamps and used for many other purposes. By about 1860, there were so few left that it was no longer practical to hunt them. In 1892, a group of scientists went to Guadulupe Island off Baja California and found what they thought were the very last eight elephant seals in existence and proceeded to kill seven of them for museum specimens. Fortunately, they did not discover a group of what must have been no more than 100 elephant seals hauled out on an isolated beach on the other side of the island. These 100 pinnipeds were probably the last remnants of the northern elephant seal population. Today, after years of protection, the population has increased to as many as 100,000 and their numbers are still growing. Elephant seals now breed on ten islands off Mexico and California and on two mainland points in California.

Elephant seals accomplish some extraordinary feats in the water. For example, they dive to great depths and remain submerged for long periods; they regulate their temperature in cold water; and some of them feed on animals that are as salty as seawater. The marine adaptations, which help them to feed at sea, also enable elephant seals to perform extraordinary feats on land. One of these feats, fasting for long periods, plays a major role in their reproductive competition because the animals are not forced to leave their place on the beach to search for food.

The transition from fasting on land to feeding in the open ocean necessitates an incredible physiological change. The seals blubber which helps it stay warm in the sea, supplies the animal with energy and water during its long fasts on land. When it goes to sea and feeds, its digestive system, which has been essentially turned off, begins to function again. All of the elephant seal adaptations for diving-storing oxygen in blood, using fat for thermoregulation and kidneys for concentrating salts- are not new adaptations. They are however, more developed in the elephant seal than in terrestrial mammals, probably because of the specific demands of the marine environment.

Time-depth recorders placed on elephant seals have been used to record the depth and duration of their dives and the time spent recovering on the surface. Before elephant seal dives were recorded, the maximum dive depth on record was for the sperm whale at 1,140 m. In 1991, six adult male elephant seals were recorded and over 36,000 dives documented. The diving endurance abilities of northern elephant seals to sustain repetitive long breathhold dives for 4-5 months with little time at the surface between dives were found to be remarkable. The dive depths for the elephant seal bulls measured at 1,333 m and 1,529 m were determined to be the deepest yet measured for any air-breathing vertebrate.

INTO
THE ACTIVITIES
Elephant Seal Images:
Show the students the "Elephant Seal" slide show or a videotape about elephant seals. Or use books, models, and/or posters to illustrate a talk on elephant seals.

While watching the videotape, freeze the frame or if using slides, stop on a particular slide and ask the students to write down a question and/or an observation about the elephant seals as if they were a biologist taking field notes. Have each student include a "field sketch" of an elephant seal.

Class Brainstorm and Cluster Diagram:
Have the students join cooperative groups and use their questions and observations as a starting point for a group brainstorm about elephant seals. Have the groups categorize their ideas into a cluster diagram. Then have the groups share their brainstorms and cluster diagrams as you record their ideas on the board.

Individual Anticipatory Chart:
Have students complete the chart as they watch a videotape or look at pictures or other visuals and listen to a lecturette about elephant seals. The questions should reflect what is actually being shown in your particular elephant seal images or as told in your elephant seal lecturette.

Example Questions:
True
False
Elephant seals were hunted for their fur.
Blubber helps elephant seals stay warm in water and allows them to fast on land.
Elephant seals dive deeper than any other air breathing animal.

Group Anticipatory Chart:
Have cooperative groups complete the first two columns of the anticipatory chart:

What I already know about elephant seals
What I want to find out about elephant seals
What I learned about elephant seals

Then have the groups draw a picture of the elephant seal in its habitat.
Have the groups share their charts and drawings and then post them on the walls for display and future reference.

Partner Parade:
Do you think your body would work very well to keep you afloat, warm, and give you the ability to catch food in the ocean?
What parts of your body would help you in each of these activities?
How many elephant seal body parts do you already know?
How does the elephant seal use these parts of its body to be successful in the ocean (e.g., be able to stay afloat, warm, capture food and etc.)?
How are elephant seals built differently from you? What do you have in common with elephant seals?
Think about lying on a sandy beach. What do you notice as you lie there? Too hot? Too sunburned? Too thirsty? How do you solve the problems you would face when visiting a California beach with cold ocean water and hot, dry sandy beaches? How do you think elephant seals solve these problems?
Think about how you must have been as a newborn and the changes that took place in your life leading up to the age you are now. How has your life changed? What do you think will be the next big change in your life? What do you think it will feel like to be your parent's age? Will you need different things?

Individual Recording:
After the Partner Parade, have each student write down as much as they can remember from the discussions.

Have the students take their information into their cooperative groups where they will illustrate the various body parts of elephant seals. Have them include

labels of the parts and descriptions of the functions and which phase of the life cycle they have depicted.

Group Organizer:
Have cooperative groups complete the following table and then share their results on a class chart.

	ELEPHANT SEALS **STAGE** **APPEARANCE** **BEHAVIOR**
Pups	
Weaners	
Yearlings	
	X
	X
Males	
Females	

Portfolio Assessment:
Teacher observations or student self-assessment of participation in all activities; Written (pictures or words) individual and group record from each activity; Completed Anticipatory Charts; Group Brainstorm/Cluster Diagrams

THROUGH
THE ACTIVITIES
Part 1: The Jigsaw
Pass out one set of either "Adaptation" or "Life Cycle" cards for each cooperative group of about 6 students. Have students number off (1-6) in each group. You could begin by having students meet in "expert groups" first, for example, all those with "thermoregulation" cards meet together to insure that everyone understands their bit before sharing their information with their cooperative group.

Tell the students that they are responsible for dividing the cards up among themselves, individually learning the information on their cards and teaching it to the rest of their group.

Emphasize how the game show will work so that students will really teach their information bits to one another and help each other to actually learn what was on each card. Tell students you will also be looking for and awarding points for social skills of encouraging and checking for understanding. These points will be added to the game show tally.

Give groups 15-30 minutes to teach each other their jigsawed bits of information. Tell the students that at the end of the period, they will

participate as contestants in a GAME SHOW. By that time, all the bits of information should have been shared with other members of their group. Each student should then be able to describe either a number of adaptations or parts of the life cycle in the correct sequence (not just the bit on their card), depending on which set of cards they were using.

Part 2: The Game Show

Have the students pass in the cards and stop sharing information. Arrange the class so that all the groups with Adaptation cards are on one side of the room and those with Life Cycle cards on the other. For the Game show, all the Adaptation groups will now work together on the same team, and so will the Life Cycle groups. Anyone in the Adaptation group should be able to describe several elephant seal adaptations and likewise anyone in the Life Cycle group should be able to describe several bits from that set. Remember that life cycle students must not only recall a piece of the life cycle, but must also place it correctly in the sequence of other life cycle events already described.

Make a chart on the board with two columns, one labeled Adaptations and the other Life Cycle. As answers are given, write them down on the board or have the student write them along with the awarded points. Alternatively, instead of writing the answers, a sketch can be made.

Use Numbered Heads Together to choose a student within a cooperative group to describe an adaptation or a part of the life cycle depending on which set of cards they had. The cooperative groups can discuss their answer and then after you again repeat the "question", pick a number out of a "hat", announce it to the class, and the student with that number then stands and gives the answer.

If that student can describe a "bit" of information, that entire side of the room gets 5 points.

If that student isn't able to give an answer, pick another number and call on another member of that same cooperative group. If the second student can answer, that entire side of the room gets 3 points.

If that student is unable to answer, pick another number and call on another cooperative group from that side of the room. If that student can give an answer, then the entire side gets 1 point..

If that student is unable to answer, start on the other side of the room and proceed as in above.

Each side gets three chances and then it is the other side's turn, whether or not they were able to answer correctly. The highest possible score for one

round of three answers would be 15 if each of three students were able to answer correctly.

At the end of the game show, play a "BONUS ROUND". Put all the Adaptation and Life Cycle "bits" together in a hat. Volunteer students can draw one and act it out as a charade for their teammates. If they guess correctly within 2 minutes, they are awarded another 6 points. *You might also play a bonus round by posing a synthesis question to both groups.*

Remember to add in the points for social skills. You might want to provide the "winning" side of the room with a special reward or prize--e.g., 10 extra minutes of recess. Or tell both teams that if they score over a certain amount they will get a reward and that if the two teams combined score is above 2X that amount, they will get an additional reward.

Part 3: Alternative to game show

Tell students that at the end of the period, they will take an elephant seal quiz individually, but that their scores will be added together to get a "group score". If their group scores 90%-100% no one in the group has to take the quiz again. If their group score is less than 90% or better, provide some special prize--e.g., 10 extra minutes of recess.

Give the following quiz to check individuals: Adaptation group describes 7-10 adaptations, Life Cycle group describes 7-10 events in the life cycle of elephant seals in the order in which they occur. Answers can be in words or pictures.

Have students switch and correct each others' papers. Add up group scores; if the group score is over 90% correct they are finished. If lower than 90%, have them return to their groups for more group teaching.

Have students switch card sets and do the activity again so that every group studies both adaptation and life cycle.

Student Posters:

Have each group select one of the following topics to represent graphically on a poster. Have the groups share their poster with the rest of the class. Topics:

What might an elephant seal/island food web look like? Who are the predators and what are their prey? Where does the elephant seal fit into this web? Elephant seals mainly eat squid, but also take skates, rays, ratfish and hake.

Elephant seals have a number of adaptations that help them to be successful for long periods of time on land and also to dive for long periods of time to great depths. What adaptations help it to be successful both on land and at sea?

Elephant seals are marine mammals, but like other seals and sea lions, are still dependent on land for mating and giving birth. How does this requirement show up in their adaptations and life cycle?

Elephant seals fast and survive without drinking water for up to 3 months on the beach. What are the adaptations that allow it to survive without water?

Elephant seals are ideal for studying reproduction and fasting because of the following traits: (1) elephant seals are unafraid of people and unlike most other pinnipeds, they probably won't flee into the water. This can be used to advantage because when the seals are asleep, they can be marked so that individuals can be recognized, aged, and followed for the rest of their lives. (2) Elephant seals breed at the same time and place every year on known island rookeries so scientists can get there first and plan their study. (3) The animals are large and slow moving and most of the reproductive activities occur on the beach where they can be watched.

Group Anticipatory Chart Completion:
Have students complete the last column "What I Learned About Elephant Seals" from the INTO Group Anticipatory Chart. Have the groups review "What I Already Know" and "What I Want to Find Out" columns to make changes and determine if all their questions have been answered.

Class Book:
1. Have students pair-up within their cooperative groups and select an adaptation or life cycle from their Group Anticipatory Chart to develop into a one-page contribution to a class book on elephant seals.
2. Each pairs' contribution should be their interpretation of that adaptation or part of the life cycle. Their contribution can be in the form of statements, prose, poetry or haiku and should include graphics of some kind.
3. Have each pair if appropriate, add at least one statement in a non-English language to their page.

Extended Anticipatory Chart:
1. Have students fill in this chart after again watching the video or listening to the same story use for the INTO Individual Anticipatory Chart. This gives the students the opportunity to self correct.
2. Ask if there are questions for which we still don't have an answer? What other questions do they still want answered?

CORRECT?

?

WHY NOT? Explain in your own words

YES

NO

1.

2.

Portfolio Assessment:
Teacher observation or student self-assessment of participation in each activity; Teacher observation of Encouraging and Checking for Understanding; Student Posters; Class Book contribution; Individual Anticipatory Chart completion

BEYOND
THE ACTIVITIES
Extended Activities/Projects:
Have students write skits and act out a day in the life of the elephant seal. Students can make hat masks or full costumes and then put on a performance for another class.

Have students draw a large mural illustrating elephant seal life on the beach and at sea including their food web.

Make life-size three dimensional representatives of elephant seal pups and females using cardboard cutouts or butcher paper stuffed with crumpled newspaper and poster paint. Draw lifesize adults as murals on the playground or walls. Alternatively, draw an outline of the seals on a sheet sewn together or butcher paper taped together to achieve the appropriate size. Compare the size of the male adult elephant seal to other seals and to whales, people, cars and etc. Female elephant seals are in about 10 feet long and weigh about 650 pounds, males are 15-16 feet long and weigh up to 6,000 pounds.

Recommended books about elephant seals: Marine Mammals edited by Delphine Haley; Elephant Seals by Sylvia Johnson, Lerner Pub.; Ano Nuevo: A Childrens Guide by Judy Beach-Balthis; Elephant Seal Island by Evelyn Shaw; Seals and Sea Lions by Blake Pub.; Zoobooks "Seals and Sea Lions"; Natural History of Ano Nuevo by Le Boeuf and Kaza; Mirounga, A Guide to Elephant Seals by Sheri Howe.

Have students continue learning about seals and sea lions by researching how different cultures have used, co-existed with or destroyed pinnipeds for thousands of years in their quest for meat, blubber and furs.

Field Trips:
Visit Ano Nuevo State Reserve in Pescadero, CA 75 miles south of San Francisco in winter to see breeding elephant seals. In Summer, the seals can be seen molting on the beach. Or take a field trip to the California Marine Mammal Center in the Marin Headlands to see pups being rehabilitated for release. Also, visit the California Academy of Sciences in Golden Gate Park, San Francisco and spend time in the "Wild California" Exhibit which depicts lifesize seals.

Debriefing:
Have cooperative groups discuss what helped them accomplish their tasks successfully and what were road blocks to their progress. Did attentive listening help?

Have students make a class list with visual representations of "helpers" and "road blocks".

Written by Catherine Halversen from an activity by Craig Strang.

ADAPTATION CARDS

Conserving Water

Elephant seals save water by breathing irregularly and holding their breath for up to 30 minutes at a time. They then exhale their breath very slowly through honeycomb-like nasal passages. This allows moisture in their breath to cool and condense in their bodies rather than losing the moisture to the air. Try breathing on a piece of glass. Did you "lose" any moisture? An elephant seal wouldn't.(adaptation)

Fasting

Males elephant seals do not eat or drink for 3 months while they are on land trying to establish and maintain dominance over other males. If they were to leave their harem, other males may mate with the females. Female elephant seals fast for a month while they give birth, nurse their pups, and copulate. If the females were to leave their pups, the pups may be killed by other females. Weaners fast for 2-3 months after weaning. This may be an advantage because it postpones the time they need to search for food until prey is more abundant.

Fasting and Removing Wastes

Animals need to flush wastes out of their bodies which were formed by the use of food for energy. Mammals produce urine to flush toxins out of their bodies. Less urine is formed while fasting and burning fat than when eating protein. Elephant seals have large and powerful kidneys, an adaptation that concentrates large amounts of toxins into a small amount of urine. This helps them to save precious water while fasting. Elephant seal urine is thick and brightly colored.(adaptation)

Energy from Fat

Male elephant seals lose 1/3 of their body weight during their 3 month fast on land. Blubber is an adaptation for animals that fast. When they are fasting, elephant seals use their blubber as stored energy. As they use their blubber for "food" a chemical by -product of their metabolism is water. This is the only way that they can get enough energy and water while they are fasting. (adaptation)

Thermoregulation

Blubber is a good adaptation for staying warm in cold water. It insulates like a wetsuit. Imagine that a human wetsuit is a quarter inch thick, and an elephant seal blubber layer may be more than 4 inches thick! The boiled down blubber can produce as much as 150 gallons of oil So much blubber makes it hard to stay cool on land so when fasting, elephant seals often sleep in tidepools or rain puddles. This is a good adaptation for staying cool and losing less water to evaporation.(adaptation)

Size and Thermoregulation

Elephant seals are big. Males grow to be 15 ft. long and weigh as much as 4 minivans. They put on a huge fat store and in males the blubber may account for 50% of its weight or about 1 ton of blubber. This is an adaptation to help them stay warm. The bigger an animals is, the less surface area it has in relation to its volume, so it loses less heat in the cold water, and it stores heat inside more efficiently.(adaptation)

Big Noses and Chest Shields

As a secondary sex trait (like a man's beard), male elephant seals acquire a hard chest shield of thickened skin and scar tissue. This is an adaptation to protect them from major injuries when fighting with other males. By the time a seal reaches maturity at about 5 years, its nose may be 1-2 ft long and the bigger it is, the higher he ranks. The size of the males nose and the loudness of their vocal threats help them to save energy by avoiding actual battles. (adapt.)

Delayed Implantation

Almost all female elephant seals mate and have young every year and the pups born one year are the products of previous year's mating. However,a female elephant seal does not become pregnant right away after copulating. Even though the gestation period is only 8 months, development stalls for nearly 3 months until the sperm implants on the wall of her uterus. This delayed implantation is a good adaptation for allowing mom to build her strength back up before the new fetus begins to develop. This schedule also makes it possible for the pups to be born at the same time every year when the females haul out on land. (adapt.)

Female Choice in Mates

Female elephant seals have some choice in deciding with which male they will mate. Although male elephant seals are three times bigger than females, the females don't let themselves get pushed around much. If they are not ready to mate, or when approached by a male other than the dominant bull, the females launch a protest squawk that can be heard by the dominant male even if he was in the next county. This behavioral adaptation insures that they copulate with the biggest, strongest males who will chase off the less dominant males. (adaptation)

Deep Continuous Diving at Sea

Elephant seals dive deeper and longer and more often than any other pinniped. Male elephant seals dive to over 5,000 feet deep, about four Empire State Buildings! They stay down an average of 22 minutes and may last as long as 77 minutes underwater. They spend three-five minutes resting at the surface and then dive again. They do this continuously, spending 85% to 90% of their time at sea underwater. Scientists are not sure how elephant seals accomplish this, but at such great depths elephant seals have almost no competition for their main food, squid, and their only predator, the white shark has never been found below 100 meters.(adaptation)

Life Cycle Cards

November

Elephant seal yearlings arrive on the islands, but most only stay for a few weeks before returning to the ocean.

December

Adult and sub-adult males arrive at island rookeries where they fight with each other to establish a dominance hierarchy, or "pecking order." The biggest, strongest bull is called the Alpha Bull and gets to mate with the most females.

Late December and Early January

Females arrive at island rookeries and form in groups, called harems, which are each guarded by an Alpha Bull. This male protects them from being approached by other males intent on mating with them. There may be over 50 females in one harem. Larger harems may have more than one Alpha Bull.

Females Give Birth

Females are pregnant when they arrive at the island. They give birth to one pup 3-6 days after they arrive. Pups weigh 65-90 lbs. at birth.

Fasting during Breeding Season

Both male and female elephant seals fast during the breeding season. Males fast from the time they arrive in December until all the females have left in late February or March.

Nursing

Mom nurses her pup for about 28 days. She fasts during this entire time, so as not to abandon her pup, which would be lost or killed if left alone in the harem.

Weaning the Pup

One month after birth, the pup weighs 250-400 lbs and is ready to be weaned. The mother then copulates, usually with the Alpha Bull. At this point the female weans her pup and leaves the island.

Mating

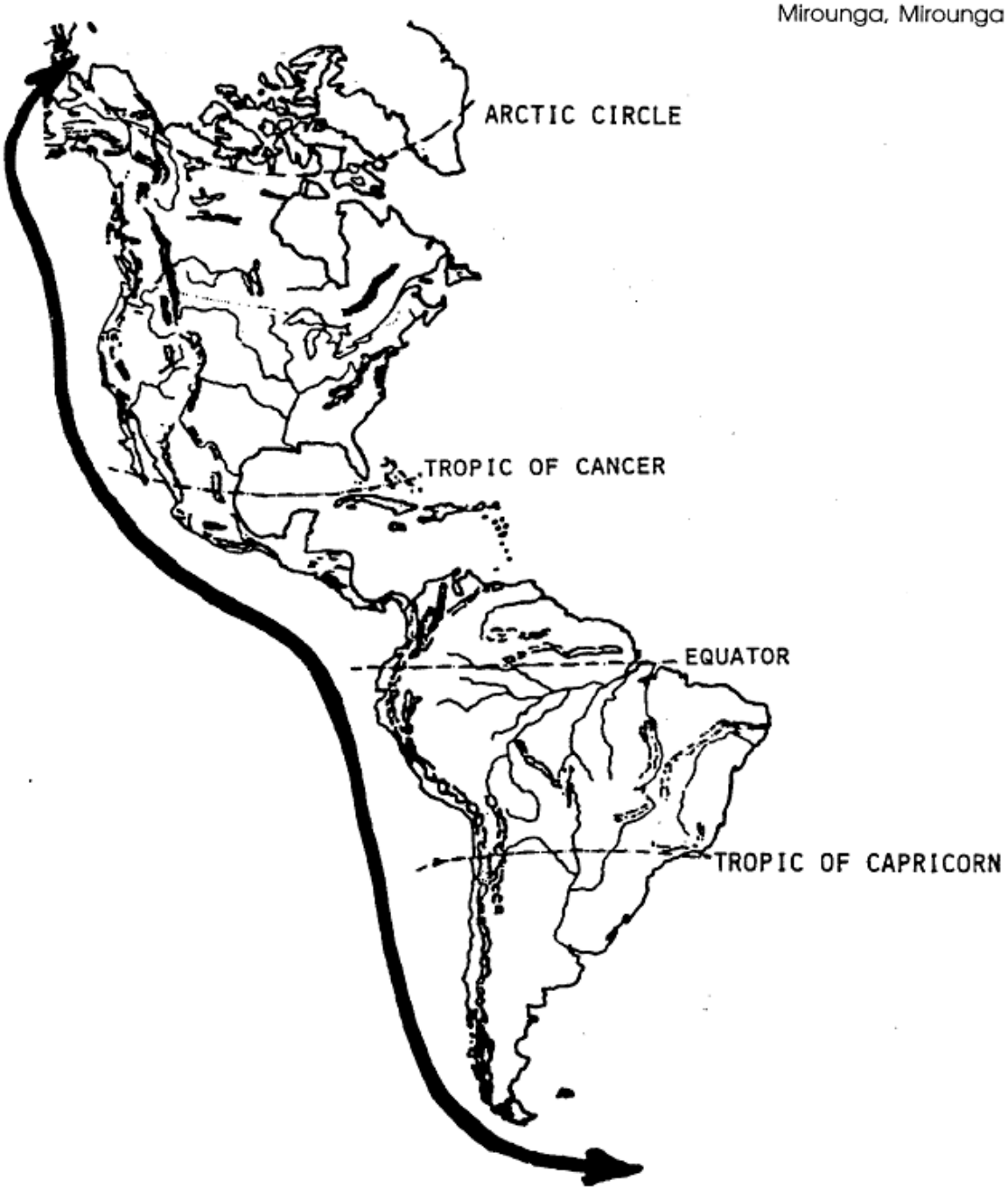
After the female weans her pup and copulates with the Alpha Bull, she begins feeding again on squid and fish. She dives continuously to over 4,000 feet deep and only spends 10%-15% of her time at the surface resting. Even though she has copulated, she does not get pregnant right away. "Delayed implantation" is a good adaptation which allows the female to build up her strength before the new fetus begins to develop.

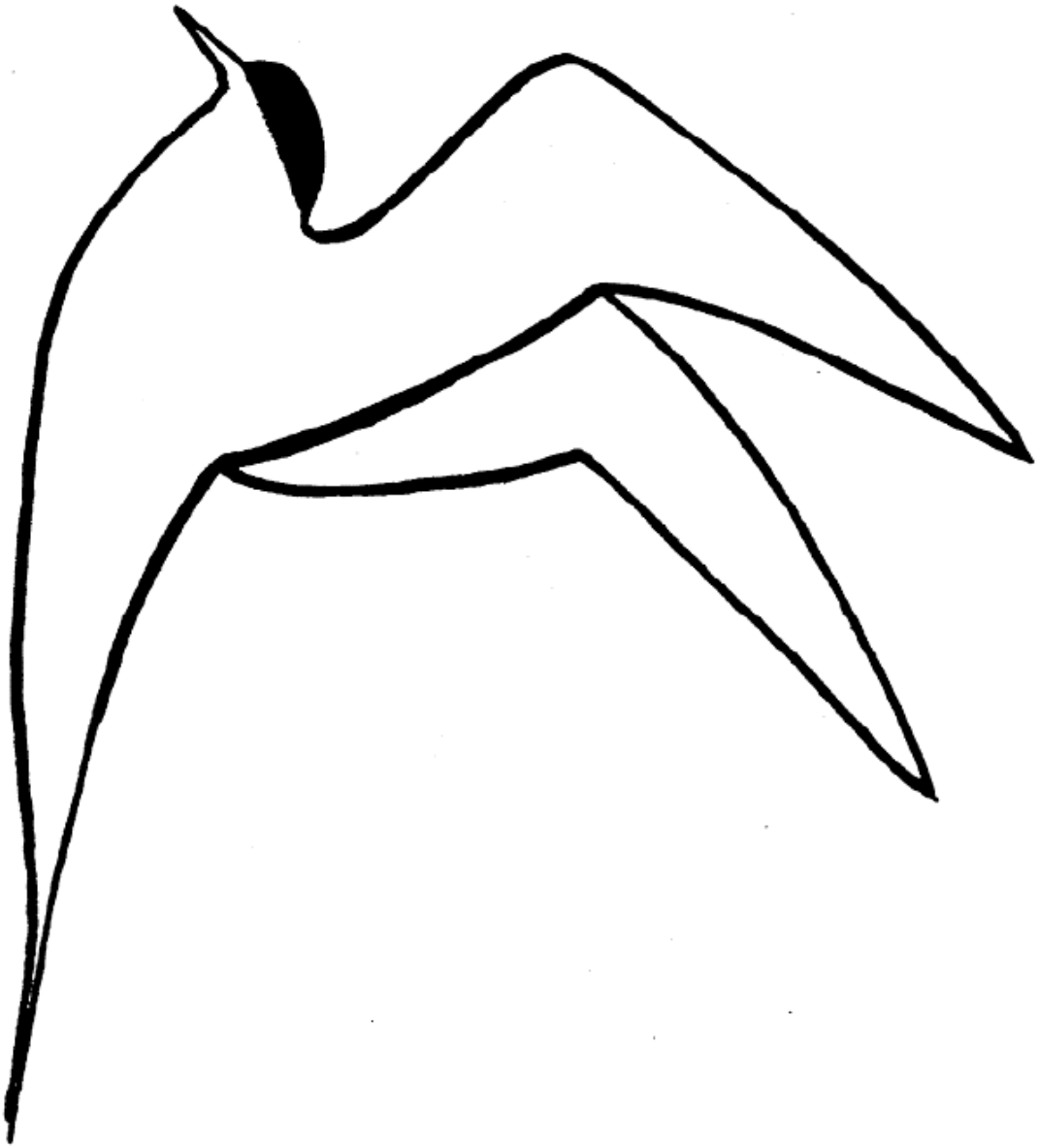
Weaners

Weaned pups, called "weaners", gather together in groups, or pods on the beach. Gradually they begin to explore the ocean, teaching themselves how to swim and catch fish.

Weaners Go to Sea

Weaners remain on the island for 8-12 weeks, living primarily off accumulated fat. Most weaners depart in mid-April and disperse northward. Only 50% of pups survive their first year, to return to where they were born the next fall.





4,000 miles Bacteria and important for breaking down dead animals into detritus. What is their role in the food web? _____ (decomposer)	4,000 miles As pesticides accumulate in fishes and then fish-eating pelicans, their effects are magnified. This is called _____. (biological magnification)
4,000 miles The meeting places of two major ocean currents often have more kinds of plants and animals or greater _____ than regions on either side. (diversity)	4,000 miles Steller sea cows were hunted to death and elephant seals were almost hunted to _____. (extinction)
4,000 miles Drifting larvae and young fish graze on microscopic plants and are examples of _____. (zooplankton)	4,000 miles Seabirds and sea otters are protected from cold water by a layer of air _____. (insulation)
3,000 miles If you can't photosynthesize or make your own food, you must be a _____. (consumer)	3,000 miles Tidepools, sandy beach, and the open ocean are all examples of biological _____. (habitats)
3,000 miles All phytoplankton must live in the upper light layer of ocean, the _____. (photic zone)	3,000 miles OFten half the elephant seal pups born each year die before the next year. 50 is the rate of death or _____. (mortality)
3,000 miles Common dolphins, blue whales, and albatross are all animals of this open region, the _____ zone. (pelagic)	3,000 miles Gray whales travel from Alaska to Baja California for their annual winter _____. (migration)

3,000 miles After cormorant chicks fledge from the nest, they look for food and spread out from home or _____. (dispersal)	3,000 miles Seabirds are vulnerable to the serious dangers of oil _____. (pollution)
3,000 miles Euphausiid shrimp live best at 9-11°C. Colder or warmer ocean water marks the _____ of their range. (limits)	3,000 miles If you stretched a string across the beach and counted all the sand crabs, flies, and beachhoppers within an inch of the string, you would be sampling a _____. (transect)
3,000 miles Someone who eats fish and chips, shrimp, and sushi is a _____. (consumer)	3,000 miles The strong northwest winds of spring blow water off shore to bring the deep cold water up top. This is known as _____. (upwelling)
2,000 miles The big river of ocean water flowing south from Alaska along California is the California _____. (current)	2,000 miles Arctic Terns catch live fish for their meals, so they are _____. (predators)
2,000 miles During heavy winter storms, mother elephant seals squablle for space on the beach. This fight for space is called _____. (competition)	2,000 miles If you counted all the living sea stars in the rocky intertidal zone, you would know the size of the sea star _____. (population)
2,000 miles Microscopic marine plants that make sugar to feed small animals are _____. (phytoplankton)	2,000 miles When a bird trades its feathers in, it is going through _____. (molt)

1,000 miles Each day on the California coast, we have two high and two low _____. (tides)	1,000 miles Many beach insects eat tiny pieces of dead plants and animals, What is this food called? _____ (detritus)
1,000 miles The role of a white shark in the ocean is to eat seals and sea lions near their haul-out areas. This describes the white shark's _____. (niche)	1,000 miles The study of plants and animals in the ocean is called _____. (marine biology)
1,000 miles White sharks eat seals eat fish eat plankton in the marine _____. (food web)	1,000 miles Shearwaters have long, soaring wings which allow them to fly long distances over the ocean in search of food. Since this helps them to survive in their habitat, long wings in shearwaters are an (adaptation).