Sandy Beach: Background Information & Pre and Post Activities

BACKGROUND INFORMATION

BASIC ECOLOGICAL CONCEPTS

Ecology is the study of the relationships between organisms and their environments. An ecologist asks questions like: Where does this organism live and what characteristics make it particularly suited for that location? How does this organism get its food? What other organisms eat it? By asking questions such as these some basic principles have emerged. Understanding the following basic ecological concepts help us appreciate the complexity of life residing in and around the Bay.

Everything is related to everything else

Perhaps the easiest place to see interdependence in the environment is to look at food. All food on this planet is essentially made by plants through the process of *photosynthesis. Herbivores* are animals, which depend directly on plants for food. *Carnivores* eat herbivores. Take away all of the plants and there would be no animals. Can a plant, then, exist independently of all other organisms? No. Although it doesn't eat, a plant needs *nutrients* and is dependent on *decomposers* (bacteria and fungi) to break down dead organisms, thereby releasing these nutrients for use by the living plant.

Everything depends on something else

All organisms are also dependent on factors in the physical environment. They must have a source of water. Animals must have oxygen to breathe. Plants must have sunlight to perform photosynthesis. You can probably think of many more examples of how organisms are dependent on their environments.

Everything must go somewhere

No object ever disappears completely from the face of the earth. It may be broken down into atoms and be used to build something else, but those atoms are still there. In this way, nature deals with waste by recycling. Any plant or animal that does not become food for some animal becomes food for decomposers, which free the nutrients to be used again. Anything that cannot be decomposed must remain in the environment as it is. What are some examples of this kind of waste? The next time you throw something away, you might remember that there really is no "away" to throw it to.

Earth's resources are limited

How often do you run out of time to do what you want or need to do? Everyone knows that each day only has so much time in it, and that we have to be careful how we use it if we are going to accomplish everything we need to. The earth's available resources are like time in that we have to be careful how we use them, or they might run out. There is only so much gold, so much petroleum, so much fresh water, so much food, and so much space. All organisms are limited by the availability of resources, but humans have a special opportunity and a special responsibility. Although plants cannot make a decision to conserve clean water, humans can. To do this intelligently we must find out how much of each resource is available and then we must budget our use. We must also think about recycling. The earth can recycle its components naturally but humans must make special efforts to preserve the natural resources.

SANDY BEACH ECOSYSTEM

Most people living near the coast, as beachcombers, sunbathers, surfers, or naturalists have likely paid many visits to one of California's most striking and beloved coastal habitats, the sandy beaches. Unlike the rocky portions of the Pacific Coast, visibly teeming with a diversity of animals, sandy beaches often appear barren and windy, strewn with dead algae, shells, and jellies that have been washed ashore. There are, however, a great number of well-adapted animals that make up the sandy beach community. Most of these animals burrow into the constantly shifting sand to protect themselves from waves and predation.

Beaches form in places where wave action is strong enough to wash away small sediment particles like mud and silt yet gentle enough to allow sand to accumulate. The color and texture of a sandy beach depends on a variety of factors. The size of the sand grains varies with the degree of exposure to the open water and the amount of wave action. Large, pounding waves create fine sand, which stays in suspension and is carried into deeper water. Hence, only pebbles remain on a beach with heavy wave action. Protected beaches are typically made up of small sand grains and sediments, which are allowed settle out in a calmer environment. California sand itself is mostly composed of the following minerals: quartz, hornblend, feldspar, garnet, and augite. These minerals arrive at the coastal areas via eroding sea cliffs or weathering mountains (which travel to the coast by way of rivers). The color of the sand varies as mineral concentrations differ from area to area.

The shape of the beach is determined by the shoreline. Sand is constantly in motion due to wind, waves, and currents. Because of Northwesterly winds, the movement of sand and debris is always towards the south.

Wave action is the dominant force that determines the look and shifting character of a beach. Visit a beach repeatedly from season to season and you will notice that the look, or profile, of the same beach changes. During summer, when weather conditions are calm, the beach profile is typically wide with a high terrace of sand, called a berm, built by waves.

In contrast the berm is typically low in winter months. The winter storms create severe waves, which erode the berm and carry the sand offshore.

The constant shifting of sand on a beach creates a tough living environment for the animals that reside there. The moving sand offers no firm place for attachment; therefore most beach animals must burrow beneath the surface of the sand. Life under the sand protects these animals from physical forces such as direct contact with wave action, temperature fluctuations, the drying sun, and varying light intensity. However, animals do encounter problems and stresses due to their burrowing lifestyle. These problems include abrasion of the shifting sand on the animal's body, as well as difficulties finding food, receiving enough oxygen, and finding a mate.

ZONATION

Because of the daily rise and fall of the tides each day, there are clear differences in horizontal sections of beach from the water line up towards the dunes. This is due in part to exposure gradients (length of exposure to air vs. water coverage). Scientists have noticed that these differences are important because they limit what organisms can survive in that section or zone of the shoreline. These sections have been categorized and described as the following: High tide zone, middle tide zone, and low tide zone. A short description of each zone follows.

High Tide Zone	**Middle Tide Zone**	**Low Tide Zone**
What lives here?	*What lives here?*	*What lives here?*
Beach Hoppers	Sand Crabs	Pismo Clams
Flies	Polychaete Worms	Moon Snails
Birds	Amphipods	Sand Dollars
	Diatoms	Olive Snails
	Birds	Fish

<u>High Tide Zone</u>

This zone is comprised mostly of beach wrack. Beach wrack is usually found deposited well up the beach toward the high tide line. Beach wrack consists of drift plants, dead animals, flies, shells and other things that have washed on shore. It is an area that supports a rich

community of organisms. Wrack is the only visible living material on top of the sand on beaches.

Middle Tide Zone
This zone is systematically washed by the advancing and retreating tides.

Low Tide Zone
This zone is rarely exposed to the air. Sand within it is constantly moving due to wave action.

Subtidal Zone
Shifting sands below the surface are among the harshest environments. At the surf line there are many small crustaceans that feed on plankton and debris while protecting themselves from the waves with hard exoskeletons.

LIVING BETWEEN THE TIDES
Animals beneath the sand are affected greatly by the changing tides and many, such as mole crabs, must migrate up and down the beach with the tides in order to eat and breathe. Other burrowing animals remain in one area or zone on the beach and must adapt to varying water coverage and air exposure. Finally, birds, which are an important presence to the community of animals on a sandy beach, are also greatly affected by tidal fluctuations on the beach. At low tide, gulls, sandpipers, willets, and godwits arrive to feed on the burrowing invertebrates.

All animals living on the beach must find enough food in order to survive and thus spend a great deal of time and energy searching out and gathering their preferred food. Animals in or on the beach may be filter feeders, eating plankton and detritus (dead organic material) which are suspended in the water, scavengers, predators, or deposit feeders. Deposit feeders, such as blood worms, ingest the sand itself and filter out the organic material trapped between the sand grains. Refer to the "Creature Feature" activity for specific information on species specific feeding strategies.

GLOSSARY

ADAPTATION	Modification of an organism in order to survive within its habitat.
ALGAE	Primitive aquatic plants that lack true stems, roots and leaves. They are in their own kingdom
BEACH WRACK	Seaweed that has washed ashore.
BENTHOS	The substrate at the bottom of a body of water; the adjectival form of benthos is benthic.
BERM	A flat, terrace-like area of sand just above the high-tide zone on a beach.
BIODEGRADABLE	Something capable of being broken down to simple compounds, especially into harmless products, by the action of microorganisms.
BIODIVERSITY	The richness, abundance and variety of life across all trophic levels of which all ecological systems, including the planet earth, are comprised.
BIVALVE	A Mollusk having two shell hinged together. e.g. clam, oyster and mussel.
CAMOUFLAGE	Method of hiding in which organisms blend in with their surroundings.
CARAPACE	In crustaceans, a hard portion of the exoskeleton that covers the fused head arid thorax.
CARNIVORE	An animal that consumes other living animals.
COMMUNITY	A group of plants or animals living in the same area and depending on one another for survival.
CONSUMER	An organism that gets its nutrients by eating other organisms.
CRUSTACEAN	An animal with a hard outside shell, antennae, mandibles and compound eyes. e.g. crabs, shrimps and barnacles.
DECOMPOSER	An organism that breaks down organic material and releases simple substances usable by other living things. Examples of decomposers are bacteria and fungi.
DECOMPOSITION	The breakdown of substances into inorganic forms.
DEPOSIT FEEDER	An animal that feeds by ingesting substrate and filtering out the small organic particles on the substrate.
DETRITIVORE	An animal that eats detritus.
DETRITUS	Dead plant and animal material.
ECOLOGY	The study of relationships between organisms and their environment.
EDGE COMMUNITY	A productive area where land and sea interface. This community, because of its proximity to land, receives huge inputs of sediment, nutrients and freshwater, which in turn supports a diversity of plants and animals.
ENDANGERED	An organism that is threatened with extinction.
ENVIRONMENT	The sum of all physical and biological factors that affect an organism.

EXOSKELETON	A hard encasement deposited on the surface of an animal, such as the outer covering of arthropods that provides protection from abrasion, predation, desiccation, etc.
FILTER FEEDER	An animal which extracts food particles by straining the water. Examples of filter feeders are clams, oysters, sponges and some fish.
FOOD CHAIN	A sequence of living organisms in an ecosystem in which members of one level feed on those in the level below and in turn are eaten by those in the level above them.
FOOD WEB	An assemblage of organisms in an ecosystem, including plants, herbivores and carnivores, which shows the relationship of "who eats whom."
FOOT	The wide, flat or wedge-shaped muscle of mollusks used for crawling, adhering and/or digging.
GEOLOGY	The study of the composition and structure of the earth.
GILL	An organ used for underwater breathing or respiration by fishes and some invertebrates.
HABITAT	The particular area in which an organism normally lives.
HERBIVORE	An animal that eats plants.
HOLDFAST	The root-like part of a seaweed that anchors it to the seafloor.
ICHTHYOLOGY	The study of fish.
INVERTEBRATE	An animal without a backbone.
MANTLE	An outer sheet of fleshy tissue (in mollusks) secreting the shell and forming the chamber to enclose the internal organs.
MOLLUSK	The second largest Phylum of animals. Mollusks have soft bodies, a foot, visceral mass, and a mantle. Most also have a shell made of calcium carbonate. Snails, clams, slugs, squid and octopus are examples of mollusks.
NEAP TIDES	Low amplitude tides that occur during quarter moons, when the moon's pull is at a right angle in relation to the pull of the sun.
OMNIVORE	An organism that eats both plant and animal material.
PHOTOSYNTHESIS	The process used by plants to make food; in this process light energy is used to combine carbon dioxide and water to make carbohydrates (sugar and starch); oxygen gas is given off as a by-product.
PLANKTON	Drifting aquatic plants and animals; the adjectival form of plankton is planktonic, and a planktonic organism is called a plankter.
POLLUTION	Harmful impact on the environment resulting from human activities.
PREDATOR	An animal that captures other animals for food.
PREY	An animal caught for food.
PRODUCER	An organism that makes its own food; an example of a producer is a green plant.
RESPIRATION	Process used by animals and plants to release energy from food; this process requires oxygen and releases carbon dioxide and water.
SALINITY	The amount of salt in the water. Measured in parts per thousand.

SALT MARSH	Salt-water wetland between terrestrial and marine ecosystems; salt marshes can also be seasonal or tidal wetlands.
SAND	Sediment particle which can be distinguished with the naked eye; particle diameters range from 1/16 (.0625) mm.
SCAVENGER	An organism that is an opportunistic feeder; scavengers usually include dead and decaying animal flesh in their diets.
SIPHONS	The feeding tubes used by some bivalves (clams and oysters) to filter plankton.
SPECIES	A population of plants or animals that are able to produce viable of with each other and not with other species.
SPRING TIDES	Occurs every two weeks near the times of either the full or new moon. These are high amplitude tides that occur when the sun, moon, and the earth are lined up.
STIPE	The stem-like part of a kelp plant.
TIDES	The daily rise and fall of the sea level along a shore, occurs twice a day on our local shores.
TUBE FEET	In echinoderms, hollow appendages filled with water and operated by the water-vascular system. Used for attachment, movement and the capture of water.
VERTEBRATE	An animal with a backbone. The back bone can be made of bone or of cartilage like in some fish (sharks and rays).
WATER-VASCULAR	A system of canals, bulbs and appendages filled with sea water. This system is involved in locomotion in echinoderms.
WETLANDS	Areas that periodically have waterlogged soils, support plants adapted to wet soil, and are covered or occasionally submerged by water.

PRE-VISIT ACTIVITIES

You may want to ask your librarian to set aside ecology or marine science books for your class, or ask students to bring books and magazines from home to share.

CAMOUFLAGE CRITTERS

Discuss the concept of camouflage, its usefulness to an animal, and perhaps how it evolved through natural selection. Have students draw an animal camouflaged for a particular environment (forest, meadow, stream bottom, etc.) Or, choose environments on the school grounds and create a critter (from paper, clay, pipe-cleaners, even raw vegetables!) that is camouflaged in those surroundings.

POST-VISIT ACTIVITIES

COASTAL CLEAN UP BAR GRAPHS

Description: The students will make bar graphs based off the statistics from the California Coastal Commission.
Objective: Students will reinforce their bar graph making skills.
Grade Level: 4th-8th
Set up time: 5 minutes
Activity time: 45 minutes
Materials: Graph paper, markers, data tables
Procedure: Divide your class into six groups and give each group one of the data tables (from below). Have your students graph the data. Have the students present their completed graphs to the group.
Discussion points: Why do you think there are more of certain types of trash? Why do you think certain trash amounts increased or decreased throughout the years?

Top 5 Trash Items

	1989	1990	1991	1992
Bags (Paper and Plastic)	31,637	49,436	42,847	58,217
Caps, Lids	33,919	55,101	51,148	58,166
Cups, Plates, Forks, Knives, Spoons	39,367	49,812	39,382	53,932
Food Wrappers/Containers	8,509	31,504	27,983	36,164
Cigarettes/Cigarette Filters	52,031	153,112	222,561	14,8079

Top 5 Trash Items

	1993	1994	1995	1996
Bags (Paper and Plastic)	12,052	62,180	42,215	48,711
Caps, Lids	40,239	61,166	41,220	45,941

Cups, Plates, Forks, Knives, Spoons	15,518	51,750	37,810	39,966
Food Wrappers/Containers	11,409	39,896	28,077	31,471
Cigarettes/Cigarette Filters	396,404	313,406	204,544	153,983

Top 5 Trash Items

	1997	**1998**	**1999**	**2000**
Bags (Paper and Plastic)	68,043	70,817	36,657	69,591
Caps, Lids	65,528	75,835	43,219	68,829
Cups, Plates, Forks, Knives, Spoons	55,260	54,142	15,502	44,631
Food Wrappers/Containers	41,921	48,098	65,735	43,821
Cigarettes/Cigarette Filters	238,500	333,876	222,523	229,928

Top 5 Trash Items

	2001	**2002**	**2003**	**2004**
Bags (Paper and Plastic)	50,592	33,268	29,207	30,841
Caps, Lids	53,736	56,951	58,863	60,016
Cups, Plates, Forks, Knives, Spoons	38,543	38,992	34,556	39,137
Food Wrappers/Containers	68,406	107,929	106,111	113,883
Cigarettes/Cigarette Filters	297,280	305,680	315,806	309,891

Top 5 Trash Items

	2005	**2006**	**2007**	**2008**
Bags (Paper and Plastic)	26,119	120,551	64,355	76,738
Caps, Lids	61,117	67,107	73,570	83,069
Cups, Plates, Forks, Knives, Spoons	40,215	33,518	40,922	34,354
Food Wrappers/Containers	98,895	10,3145	12,5038	11,4758
Cigarettes/Cigarette Filters	258,075	347,948	392,771	340,221

Top 5 Trash Items

	2009	**2010**	**2011**	**2012**
Bags (Paper and Plastic)	10,3671	95,005	88,402	63,233
Caps, Lids	99,243	64,517	68,692	48,225
Cups, Plates, Forks, Knives, Spoons	43,837	39,254	36,704	23,990
Food Wrappers/Containers	143,556	124,637	128,510	94,182

Cigarettes/Cigarette Filters	394,920	335,320	305,697	217,423

WEB OF LIFE

Have the students stand in a circle. Ask the students about the habitat they just saw (this will work for any habitat). Ask them where in that habitat all energy begins, (sun).

- Hand the student who answered correctly a ball of yarn.
- Ask what uses the sun's energy to create food (plants). Have them name a plant they saw.
- Have the student with the ball of yarn (still hanging on to the end of the string) toss the ball itself over to the "plant" student.
- Ask, "Who uses plants for energy?" And continue this discussion using herbivores, carnivores, decomposers, and of course, humans,
- With each completed step, students continue to toss the yarn to each other around the circle, creating a complex and interrelated food web.
- Now pick a random student. Because of hunters, or pollution, or loss of habitat (several reasons apply), the component he or she represents has died and must sit down. As he does so, he inadvertently creates a tug on the yarn, thus affecting other aspects of the web of life. Every student, then, who feels a tug on the yarn they are holding is affected in some way by the death of that one individual, and must sit down and tug on their own yarn.

Eventually, all students will be seated and you can discuss the results

ACTIVITY: Sandy Beach Creature Feature

Objective:

The objective of this activity is to familiarize and excite students about the creatures that live in the sandy beach.

Procedure:

There are many possibilities for classroom activities using the “Creature Feature” information cards.

You may wish to conduct an “Each One – Teach One” with your students. Make enough copies of the creature information cards so that there is one featured animal per student when pages are cut apart. Let students choose a creature card randomly. Give students time to read the card or further research their chosen organism. Props and pictures are fun additions to this activity. Then, let the each one – teach one begin. Set up teaching “stations” around the room. Devise an organized way to have the students teach and learn from each other as they move between teaching stations.

Alternate activities could include:

a. The creation of a sandy beach food web using the creature information cards and poster boards.

b. Human Impact Activity: Have students pick a creature information card and research the impacts that humans have on that specific organism.

SANDY BEACH CREATURE FEATURE

SAND CRAB

Habitat: Live under the sand and migrate up and down the beach with the tide.

Adaptations: Catch plankton with their feathery antennae sticking out of sand as the waves crash over them.

Food: Plankton.

Predators: Shorebirds, barred surfperch, and

MOON SNAIL

Habitat: Found in low tide and subtidal zone

Adaptations: The foot is larger than its shell. Can fold the foot, which is useful in grasping organisms and holding prey.

Food: Mainly clams. Prey is located primarily by scent, then grasped by the snail's foot. A hole is drilled into the clam's shell by the moon snail's

FLATFISH

Examples: Halibut, Flounders, and Sole

Habitat: Lay flat on sand.

Adaptation: Able to change colors to match sandy or pebbly bottom.

Food: These types of fish are bottom-feeding predators. Eat worms, brittle stars, clam siphons, and other fish. Young eat bottom dwelling crustaceans. Adults have been known to

PURPLE OLIVE SNAIL

Habitat: Above and below the surface in the low tide zone.

Adaptations: A keen sense of smell, which allows the snail to detect predators. At the sign of danger an olive snail will crawl away or dig into the sand.

Food: They are predators who drill into other

BEACH HOPPERS

Habitat: Beach hoppers burrow in the moist sand. Larvae live in and around algae in the wrack line. Some adults move into the dunes.

Adaptations: Large animals have developed the ability to burrow into the sand in an effort to find stability. This subterranean living also provides protection from predators and moisture during low tides or extreme heat. They can jump large distances using their tails as a spring.

SHOREBIRDS

Examples: Godwits, Gulls, Sanderlings

Habitat: Beaches and marshes

Adaptations: the shape and size of the animal's beak define Food preference.

Food: They are important predators on amphipods, insects, algae, worms, and mole crabs. They typically feed during low tide.

Predators: Foxes.

CLAMS

Examples: (Pismo, Bent-nose, etc.)

Habitat: Burrow into shallow sands.

Adaptations: Hard shell, muscular foot, burrowing abilities.

Food: Filter feeders. Eat plankton by sending two straw-like feeding tubes (siphons) up through the sand to filter the small plankton from the

SAND DOLLAR

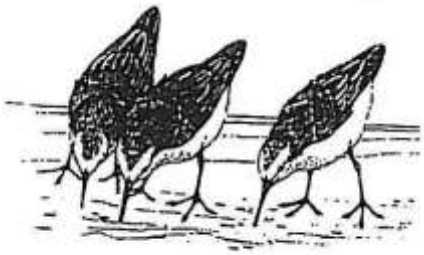
Habitat: Sit upright half-buried in the sand in low tide and subtidal zones.

Adaptations: Covered with fine fuzz of spines for movement and food capture. They use spines to capture tiny creatures riding on plankton. They eat sand and store it inside their digestive tract to serve as a weight belt, which holds them down in the shifting sand.

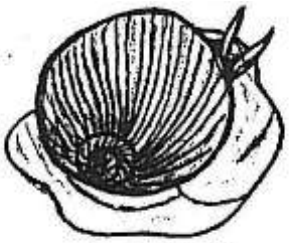
Food: They ferry food particles along fuzz to a

Beach Hopper
Orchestoidea californiana

Sand Crab
Emerita analoga

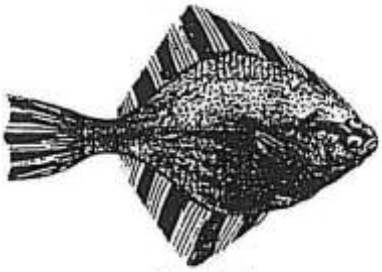


Shore Birds

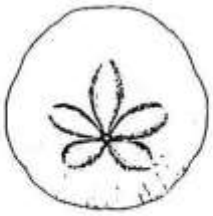


Moon Snail
Polinices reclusianus

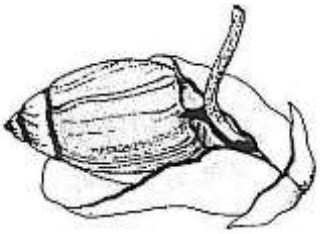
Clams
various species



Flatfish



Sand Dollar
Dendraster excentricus



Purple Olive Snails
Olivella biplicata

ACTIVITY: Sandy Beach Invent an Invertebrate

Objective:

Students will create an imaginary sandy beach invertebrate. One, given the harsh conditions on a sandy beach, that can survive and thrive in such conditions with specific adaptations invented by the student.

Background:

The sandy shore is a tough environment in which to live. Think of the last time that you spent at the beach. What animals did you see living on or under the sand? Probably not too many. The beach is an ever shifting and changing environment. There is no place to attach or hold on. Waves are constantly washing and moving sand. Birds visit frequently to get a tasty meal with their probing beaks. Tides move the pounding waves and water up and down the beach. For these reasons, sun, air exposure, sand abrasion, predation, and the search and/or competition for food are all challenges that animals need to face to be able to survive in or on the beach.

You'll need:

- Markers, crayons, pens, pencils, and paper (for picture inventions)
- Clay, straws, pipe cleaners, paper cups, cardboard, etc. (for model inventions)

Procedure:

1. Initiate a brainstorming activity with the students to create a list of possible problems and stresses for life on a sandy beach. Make a visible list for the students. Introduce the word "adaptation".
2. Give each student or group of students materials with which to invent a sandy beach invertebrate. Students must be able to report a) where their animal lives on the sandy beach b) the problems the animal might face and c) the adaptations that the animal has in order to cope with the previously stated problems.

WRITING THANK YOU LETTERS

Write letters to the instructors and/or your class sponsor to tell them about the trip. When we receive letters and pictures back from the kids our instructors remember what a thrill it is to be teachers. The sponsors also enjoy getting direct feedback from the class and teacher to reinforce that they are making a difference for kids learning science. Please include the day, date and time of your trip so we can try to remember your group a little better.