Inland Voyage

Sandy Beach Habitat Program

A discovery-based program for K-12 grade

EDUCATOR'S GUIDE

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Marine Science Institute's Educational Philosophy

As you plan an Inland Voyage Habitat Program with the Marine Science Institute, please consider how this opportunity fits within your overall instructional objective. What learning outcomes do you desire from the experience? What do you need MSI to make happen during the program? How well is the class positioned to move your desired outcomes toward a reality?

One strength of the Marine Science Institute's programs is their flexible role within the learning cycle. Is your group just beginning to generate interest in marine science **(engage)?** Or, are they "hooked" and, instead, are ready to actively experience, to form predictions and make observations **(explore)?** Have your students been developing understandings for some time, and are now ready to speak the language of marine science **(explain)?** Or, does your group have a mature understanding of marine science, perhaps including aspects that are far afield from the habitats covered in the Inland Voyage Habitat Program, and now the students are ready to relate that knowledge to their own backyard **(apply)?** Regardless of where you place your group on the learning cycle, there is a rich experience and a measurable success awaiting your program!

But…what you do before, during and after the MSI Inland Voyage Habitat Program will determine to a very large extent how strong of a partner the Inland Voyage Habitat Program will be in helping you meet your learning objectives.

INTRODUCTION TO THE INLAND VOYAGE HABITAT PROGRAM

This program guide is intended to further understanding of Marine Science Institute's Inland Voyage Habitat program curricula and program logistics. Through the use of this guide, teachers will know what to expect from our program and will gain a better understanding of the Sandy Beach habitat. The goal of the program is to instill in the students an appreciation for this diverse habitat and an understanding of how humans interact with the environment.

PROGRAM LOGISTICS

The Inland Voyage program is delivered to a school, library or camp by a vehicle called the Marine Science Mobile. Since this unit is both transport and life support for the marine organisms, the programs are presented outside and/or close to the Marine Science Mobile. We need an area accessible to the van that is large enough to set up a two-station program for up to 40 students. This area can be grassy or paved, and shade is always appreciated. If the area is separated from recess activities or any other traffic, the students will be more focused and attentive. Ultimately they will get more out of the experience if these factors are considered. Special arrangements due to weather conditions can be made if necessary.

There are seven different and exciting Inland Voyage programs that the Marine Science Institute offers to schools and groups. Five of these programs focus on marine habitats: Rocky Intertidal, Sandy Beach, Kelp Forest, Marshes and Mudflats, and Open Ocean. The two additional programs focus on groups of animals in or near the San Francisco Bay

Estuary: Bay Fish and Bay and Ocean Invertebrates. Activities for all of these programs are designed to be grade appropriate for Kindergarten to High School grade levels. The programs are all "hands-on" and discovery based, meaning that we give students the animals and equipment necessary to discover sensory or factual information about the animals and their habitats. Two instructors will guide the group through a fun-packed, fifty-minute exploration of these fascinating worlds. One class can experience more than one habitat on a given day, but due to van space and set-up needs, we can only offer two different types of programs per each visit to the school.

Our marine science instructors are specially trained to teach all ages with interesting and innovative methods that encourage interaction and problem solving. Our basic curriculum for each program is described in detail here and should prove to be quite challenging. However, we encourage you to tailor your program by telling us about a particular *theme* that your class has been studying and what level your class is at-*engage, explore, explain, or apply*. **Please fill out the student assessment form and return via mail or fax.**

PROGRAM LENGTH, GROUP SIZE, AND GRADE

Each program allows up to 40 students to participate and is 50 minutes in total length. The two instructors will give a five-minute introduction and then the class will divide into two groups, with each group participating in two 20-minute stations. To expedite this transition, we ask that the class be divided in half prior to our arrival. The program will wrap up with a brief five-minute closing discussion. We also schedule a ten-minute window between programs. The ten-minute intermission is essential to the well-being of the animals and enables staff to set-up for the next program.

ROLE OF ASSISSTING ADULTS

In order to keep program costs at a minimum, we require the participation of at least two adults. The adults are encouraged to participate in various facets of the program such as group management, animal handling, and small group activities.

SANDY BEACH HABITAT PROGRAM DESCRIPTION

During this 50-minute program, students will discover how sandy beach animals are adapted for survival. A short introduction to the habitat will be given to your group as a whole. Then the students will be divided into two equal groups, and they will rotate between two stations, guided by MSI's Marine Educators. The "stations" will focus on a) invertebrates living below the sand and b) creatures living above the sand. Students will see and touch live sand dollars, mole crabs, sea stars, clams and fish as well as turtle and bird artifacts.

Basic Ecological Concepts

Ecology is the study of the relationships between organisms and their environments. An ecologist asks questions. Where does this organism live? 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 emerge. Understanding the following basic ecological concepts will help us appreciate the complexity of life residing in the various aquatic habitats covered in the Inland Voyage Habitat program.

Everything is connected to everything else!

Perhaps the easiest place to see interdependence in the environments is to look at food. All of the food on this planet is made available initially by plants through the process of photosynthesis. Herbivores are animals that depend directly on plants for food. Carnivores eat herbivores. Take away all the plants and there would be no more animals. Is it possible for a plant, then, to exist independently of all other organisms? No. Although it does not eat animals, 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, so if there were no sun, there would be no life. You can probably think of many more examples of how organisms are interdependent 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 recycling. Any plant or animal that does not become food for some animal becomes food for decomposers when it dies. Decomposers free the nutrients so they may 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 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 do. 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 a plant 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 monitor 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 Background Information

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
This zone gets occasional wave action. This is where beach wrack is deposited.
What lives here?
Beach Hoppers,
Flies
Birds

MIDDLE TIDE ZONE
This zone is systematically washed by the advancing and retreating tides.
What lives here?
Sand Crabs
Polychaete Worms
Amphipods
Diatoms
Birds

LOW TIDE ZONE
This zone is rarely exposed to the air. Sand within it is constantly moving due to wave action.
What lives here?
Pismo Clams
Moon Snails
Sand Dollars
Olive Snails
Fish

High Tide Zone
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.

MiddleTide 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 on pages 7-9 for specific information on species specific feeding strategies.

Classroom Activity Ideas for Sandy Beach Studies

ACTIVITY #1: 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:

1. The creation of a sandy beach food web using the creature information cards and poster boards.
2. 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

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.
Food: Most are filter feeders. They eat primarily algae.
Predators: Shore beetles and birds

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 water.
Predators: Moonsnails and humans

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 central mouth. Then they clean algae and detritus off of sand grains have been filtered in.
Predators: Starfish are the main predators.

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 mollusk's shells using their radula.
Predators: Snails, octopus, and sea stars

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 humans (used for bait).

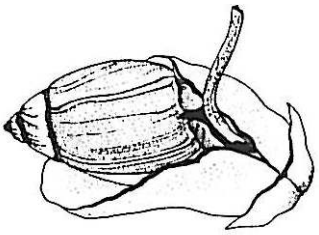
MOON SNAIL

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 radula.
Predators: Mostly rayed sea stars and other moonsnails.

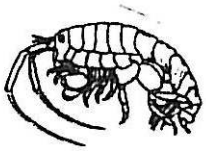
FLATFISH

Examples: Halibut, Flounders, and Sole

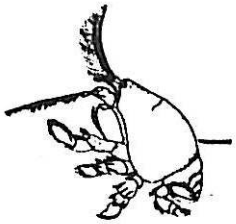
Habitat: Lay flat on sand.
Adaptation: Able to change colors to match sandy or pebbly bottom.
Food: These types of fish are bottom-feeding predators. Eat worms, brittle stars, clam siphons, and other fish. Young eat bottom dwelling crustaceans. Adults have been known to jump out of water in pursuit of anchovy, squid, croakers, or grunion.
Predators: Form a big part of the diet of dolphins, sea lions, and harbor seals.



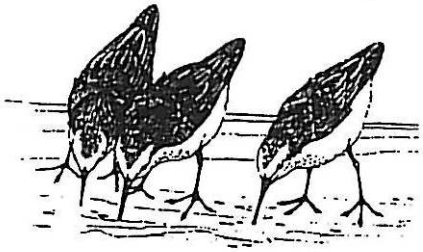
Purple Olive Snails
Olivella biplicata



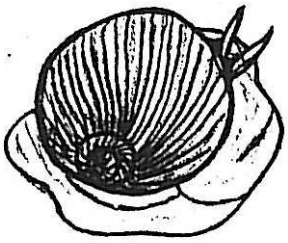
Beach Hopper
Orchestoidea californiana



Sand Crab
Emerita analoga

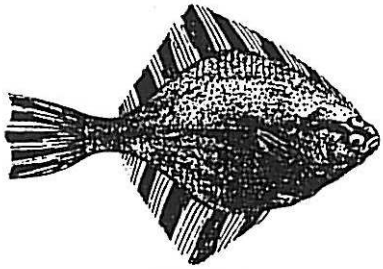


Shore Birds

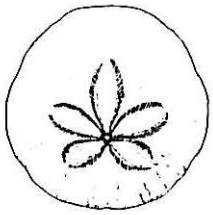


Moon Snail
Polinices reclusianus

Clams
various species



Flatfish



Sand Dollar
Dendraster excentricus

ACTIVITY #2: Invertebrate Buffet

Objective:

Students will learn through observation how invertebrates move, eat, and defend themselves from predators.

Background:

We can tell a lot about an organism just by its appearance. Invertebrates are a highly diverse group, yet, the clams found under the sand on a beach near San Francisco may have the same characteristics as clams found on the beaches in China. Because of their commonalties, both clams are grouped together in the Phylum Mollusca.

You'll need:

- Sandy beach invertebrates. Enough for each group working together in class. *There are two options available to collect a variety of invertebrates for this lab.*
  A) Go to a local fish market and buy a selection of Littleneck or local clams and squid.
  B) *Visit a local beach and……. DIG (close to the water line!) Worms, sand crabs, clams etc., can be found with a little bit of effort. Beach hoppers may be found on top of the sand. You will need a California Department of Fish and Game Collection Permit. Permits cost about $42 and are valid for two years.*
- Paper plates, paper towels, and small scissors (if you are working with dead animals)
- Student Handout: Invertebrate Buffet Chart
- Teacher Handout: Invertebrate Buffet Answer Chart
- Field Guide (optional) or "Creature Feature" picture page (page 9)
- Ocean water and buckets for live animals.

Procedure:

1. Initiate a discussion on invertebrates and adaptations necessary to survive on a sandy beach. What are some animals that you would expect to find on or under the sand at the beach? What adaptations do some of these animals have to protect themselves from the abrasive sand, from predators, from the drying sun, etc.?
2. Initiate a discussion on feeding strategies for invertebrates. Students must understand the difference between predators, scavengers, filter feeders, suspension feeders, and deposit feeders before the activity begins.
3. Introduce or reintroduce the necessary vocabulary words needed for the activity i.e. invertebrate, benthos, detritus, filter feeder, prey, scavenger, camouflage, and phylum.
4. Hand out a selection of the invertebrates, and other materials, including the Student Handout (one per student).
5. Students will examine the animals using all of their science skills (observing, communicating, comparing, categorizing and relating) while working with the animals and complete the Invertebrate Buffet chart. It may not be possible to figure out all of the answers with complete certainty, but tell the students to make their best hypotheses based on what they already know and what they observe.

***The Invertebrate Buffet Sheets can be found on the following pages.*

SANDY BEACH INVERTEBRATE BUFFET
Data Sheet

NAME: _____

DATE: _____

SPECIES OR TYPE	*SKETCH*	*HOW DOES IT MOVE ?*	*WHAT & HOW DOES IT EAT?*	*WHO IS ITS PREDATOR?*	*HOW DOES IT PROTECT ITSELF ?*

Possible words to use:

Filter feeder
Suspension feeder
Burrows or digs
Deposit feeder
Scavenger
Predator
Camouflage

SANDY BEACH INVERTEBRATE BUFFET
Teacher Answer Sheet

SPECIES OR TYPE	*SKETCH*	*HOW DOES IT MOVE ?*	*WHAT & HOW DOES IT EAT?*	*WHO IS ITS PREDATOR?*	*HOW DOES IT PROTECT ITSELF ?*
Clam		**Burrows with it's foot**	**Plankton, Filter Feeder**	**Humans, bottom fish, birds, snails (predatory)**	**Hard shell, Ability to dig deep and/or fast**
Snail		**Muscular foot**	**Shelled animals by drilling a hole**	**Birds, bottom feeding fish**	**Hard shell, Trap door over shell opening**
Worm		**Burrow, wriggle**	**Detritus, algae, other worms**	**Bottom fish, crabs, and birds**	**Protective tube, jaws**
Sand Star		**Numerous tube feet under body (no suction)**	**Snails**	**Sea otters**	**Spines around edge Fast moving. Can dig.**
Beach Hoppers		**Jumps or crawls**	**Washed up beach algae**	**Shore beetles and birds**	**Exoskeleton, burrows during the day**
Sand Crab		**Digs and burrows with hind legs**	**Plankton, filter feeder**	**Shorebirds, fish, and humans (for bait)**	**Exoskeleton, can dig and burrow really fast!**

Possible words to use:

Filter feeder
Suspension feeder
Burrows or digs
Scavenger
Predator
Camouflage
Deposit Feeder

ACTIVITY #3: 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.

Glossary

Adaptation: An adjustment to environmental conditions - the modification of an organism or its parts that help it to survive.

Beach Wrack: The seaweed that has washed ashore.

Berm: A flat, terrace-like area of sand just above the high-tide zone on a beach.

Deposit Feeder: An animal that feeds by ingesting substrate and filtering out the small organic particles on the substrate.

Detritus: Dead plant and animal matter, and the bacteria decomposing them.

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 that extracts food particles by straining the water. Examples of filter feeders are clams, oysters, sponges, and some fish.

Foot: The wide, flat or wedge-shaped muscle of mollusks used for crawling, adhering and/or digging.

Invertebrate: An animal without a backbone.

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.

Plankton: Drifting aquatic plants and animals.

Predator: An animal that captures other animals for food.

Prey: An animal caught for food.

Scavenger: An opportunistic organism that will eat just about anything for food; scavengers usually include dead and decaying animal flesh in their diet.

Siphons: The feeding tubes used by some bivalves (clams and oysters) to filter plankton.

Tides: The daily rise and fall of the sea level along a shore, occurs twice a day on our local shores.

BIBLIOGRAPHY

Armstrong, Pam, ed. Sea Searchers Handbook: Activities from the Monterey Bay Aquarium. Boulder, CO: Roberts Rhinehart Publishers, 1996

Cambell, Neil A. Biology, Second Edition. Redwood City, CA: The Benjamin/Cummings Publishing Co., 1990.

Grimmer, Karen, ed. Marine Science Institute Marine Educators Manual. Redwood City, CA: 1995.

Harbo, Rick M. Whelks to Whales: Coastal Marine Life of the Pacific Northwest. BC Canada: Harbour Publishing, 1999.

McConnaughey, Bayard and Evelyn McConnaughey. Pacific Coast. New York, NY: Chanticleer Press, Inc., 1985.

Pacific Rocky Intertidal Animals. Marine Science Institute, 2000.

Ricketts, Edward et al. Between Pacific Tides. Stanford, CA: Stanford University Press, 1985.

Snyderman, Marty. California Marine Life. Niwot, Colorado: Roberts Rhinehart Publishers, 1998.

Tidepool Expedition Educator's Guide. Marine Science Institute, 1993.