



## Invertebrates: 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.

## **BENTHIC INVERTEBRATES**

A benthic invertebrate is an animal without a backbone that lives down in the bottom sediments. As a group, the invertebrates are highly successful in the natural world and well adapted. They are found everywhere: on land and in the soil, in freshwater, in saltwater, and in the bodies of other animals. In fact, invertebrates make up 97% of all the animals on the earth. This section will be devoted to the intriguing group of invertebrates that make the Estuary their home.

## **BAY INVERTEBRATES**

Many people don't realize how many communities of invertebrates live in and on the muddy, bottom sediments of the S.F. Bay Estuary. This area is called the benthos, and is a habitat for many varieties of plant and animal life. Crabs, snails and sea squirts live on top of the Bay's mud, while clams, mussels and tube worms feel more at home in the mud. Each has its own set of adaptations to feed, move and hide from predators.

Following is information on some Bay invertebrates that may be included in your Discovery Voyage program.

### **BAY INVERTEBRATE CHARACTERISTICS**

#### **PHYLUM PORIFERA** (pore-bearing animals)

##### **Red Beard Sponge** *Microciona prolifera*

Description: Very bush-like in appearance, often mistaken for a plant, with numerous finger-

like projections.

Food: Eats bacteria and dead plant and animal material (detritus) by absorbing these particles from the water as it flows through their bodies.

Predators: Sea slugs (nudibranchs).

Origin: Atlantic Ocean.

**Fun Fact:** A sponge may also be thought of as a mini "hotel" or "apartment complex," as it provides an excellent habitat for other living creatures. One sponge may contain hundreds of tiny organisms. Sea anemones may be present, along with spider crabs, which are able to camouflage within the sponge.

## **PHYLUM MOLLUSCA** (soft-bodied animals)

### **Asian Clam** *Potamocorbula amurensis*

**Description:** Shells are white, tan or yellow. One shell is larger than the other producing a distinct "overbite".

**Food:** Filter feed on plankton.

**Predators:** Diving birds, crabs, and bottom feeding fish.

**Origin:** China and Japan.

**Fun Fact:** This clam was introduced by the ballast of ships in 1986, and has since spread throughout the Estuary.

### **Green Mud Mussel** *Musculista senhousia*

**Description:** Smooth, small (2 cm) dark shells with wavy brown and green bands.

**Food:** Filter feed on plankton and detritus.

**Predators:** Shorebirds and bottom feeding fishes.

**Origin:** Introduced from Japan with the Pacific oyster.

**Fun Facts:** Mussels are like tiny sewing machines! To keep from getting tossed about in the waves and/or tides, mussels form sticky threads, called byssal threads, and anchor themselves to the mud at the bottom of the Bay. These threads then harden and keep the animals from being swept away!

## **PHYLUM ANNELIDA** (segmented worms)

### **Tube Worm** *Asychis sp.*

**Description:** The brown, tubular structure made of mud is actually the home of the tube worm, while the long, red, slender creature inside is the worm itself.

**Food:** Because it eats much of the dead plant and animal material decomposing on the bottom, the tube worm can be thought of as one of the trash collectors of the Estuary! They are also great recyclers.

**Predators:** Bottom feeding fish and crabs.

**Origin:** Introduced to the Estuary with the Eastern oyster.

**Fun Fact:** The tube is constructed of both mud and mucus. To construct a tube, the worm eats mud and digests the living and dead microscopic plant and animal particles found inside. When finished, it secretes the mud back out again, mixed with sticky mucus, which flows down the sides of its body like a coat of paint on a house. Gradually, the tube is formed and the worm lives protected inside.

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## **PHYLUM ARTHROPODA** (jointed limbs)

### **Spider Crab** *Pyromaia tubercula*

- Description:** Pear-shaped crab with long, spindle-like legs.
- Food:** Uses front claws to eat algae and detritus.
- Predators:** Bottom fish, sharks and shorebirds.
- Origin:** Native to the Pacific Coast.
- Fun Facts:** This crab gets both its nicknames for good reason. The first is obvious because it clearly looks like a spider! The second name comes through observing the fuzzy appearance of its shell and legs. The crab takes pieces of its surroundings and attaches it to its carapace and legs. This ensures camouflage and a meal when desired.

## **PHYLUM CNIDARIA** (stinging nettle)

### **Orange Anemone** *Diadumene cincta*

- Description:** Small, approximately 1 cm, flower-like body. usually pale pink or orange in color. Often found attached to the inside of empty shells, or on sponges.
- Food:** Zooplankton. Their flower-like appearance is due to several delicate tentacles flowing in and out of the solid tube-like column of its body. These tentacles are equipped with stinging cells which immobilize prey, then carry it down its tubular column and into its mouth.
- Predators:** Snails, seastars, sea slugs (nudibranchs).
- Origin:** Atlantic Ocean.
- Fun Fact:** If a sea anemone is left undisturbed for a few minutes, you can usually see its flowery tentacles appear.

## **PHYLUM CHORDATA**

### **Solitary Tunicate or Sea Squirt** *Mogula Manhattensis*

- Description:** Globular or "bag-shaped" body, usually translucent and yellowish in color
- Food:** Filter feed on plankton using two straw-like siphons to pull water in and out of its body.
- Predators:** Mainly sharks.
- Origin:** Atlantic Ocean.
- Fun Fact:** A tunicate's body is inflated with water. When a tunicate is gently squeezed, it will squirt out water like a fountain from one of its siphons; hence, its nickname!

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## GLOSSARY

<b>ADAPTATION</b>	Modification of an organism in order to survive within its habitat.
<b>BENTHOS</b>	The substrate at the bottom of a body of water; the adjectival form of benthos is benthic.
<b>BIODEGRADABLE</b>	Something capable of being broken down to simple compounds, especially into harmless products, by the action of microorganisms.
<b>BIODIVERSITY</b>	The richness, abundance and variety of life across all trophic levels of which all ecological systems, including the planet earth, are comprised.
<b>BIVALVE</b>	A Mollusk having two shell hinged together. e.g. clam, oyster and mussel.
<b>BRACKISH</b>	Water that has more salt than fresh water but not as much as seawater.
<b>BYSSAL THREAD</b>	Tough threads of protein secreted by a gland in the foot of the mussel and used to attach it to rocks, piers etc.
<b>CAMOUFLAGE</b>	Method of hiding in which organisms blend in with their surroundings.
<b>CARAPACE</b>	In crustaceans, a hard portion of the exoskeleton that covers the fused head and thorax.
<b>CARNIVORE</b>	An animal that consumes other living animals.
<b>COMMUNITY</b>	A group of plants or animals living in the same area and depending on one another for survival.
<b>CONSUMER</b>	An organism that gets its nutrients by eating other organisms.
<b>CRUSTACEAN</b>	An animal with a hard outside shell, antennae, mandibles and compound eyes. e.g. crabs, shrimps and barnacles.
<b>DECOMPOSER</b>	An organism that breaks down organic material and releases simple substances usable by other living things. Examples of decomposers are bacteria and fungi.
<b>DECOMPOSITION</b>	The breakdown of substances into inorganic forms.
<b>DEPOSIT FEEDER</b>	An animal that feeds by ingesting substrate and filtering out the small organic particles on the substrate.
<b>DETRITIVORE</b>	An animal that eats detritus.
<b>DETRITUS</b>	Dead plant and animal material.
<b>DIATOM</b>	A type of microscopic, one-celled photosynthetic organism. All diatoms are surrounded by a silica shell and most are a golden brown in color.
<b>DICHOTOMOUS KEY</b>	A tool used to identify organisms based on their physical features.
<b>DISSOLVED OXYGEN</b>	Oxygen that has dissolved in water and can be used for respiration.
<b>ECOLOGY</b>	The study of relationships between organisms and their environment.
<b>EDGE COMMUNITY</b>	A productive area where land and sea interface. This community, because of its proximity to land, receives huge inputs of sediment,

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	nutrients and freshwater, which in turn supports a diversity of plants and animals.
<b>ENDANGERED</b>	An organism that is threatened with extinction.
<b>ENVIRONMENT</b>	The sum of all physical and biological factors that affect an organism.
<b>ESTUARY</b>	A semi-enclosed body of water where salt water and fresh water meet and mix.
<b>EXOSKELETON</b>	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.
<b>FILTER FEEDER</b>	An animal which extracts food particles by straining the water. Examples of filter feeders are clams, oysters, sponges and some fish.
<b>FOOD CHAIN</b>	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.
<b>FOOD WEB</b>	An assemblage of organisms in an ecosystem, including plants, herbivores and carnivores, which shows the relationship of "who eats whom."
<b>FOOT</b>	The wide, flat or wedge-shaped muscle of mollusks used for crawling, adhering and/or digging.
<b>GEOLOGY</b>	The study of the composition and structure of the earth.
<b>GILL</b>	An organ used for underwater breathing or respiration by fishes and some invertebrates.
<b>HABITAT</b>	The particular area in which an organism normally lives.
<b>HERBIVORE</b>	An animal that eats plants.
<b>INVERTEBRATE</b>	An animal without a backbone.
<b>MANTLE</b>	An outer sheet of fleshy tissue (in mollusks) secreting the shell and forming the chamber to enclose the internal organs.
<b>MOLLUSK</b>	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.
<b>NEMATOCYST</b>	In cnidarians, stinging capsules used in defense and gathering food.
<b>NUTRIENTS</b>	The raw materials necessary for continuing life processes.
<b>OMNIVORE</b>	An organism that eats both plant and animal material.
<b>OVOVIVIPAROUS</b>	Reproductive strategy where mother bear young that develop internally but are unattached to a placenta inside the mother (born live from an egg).
<b>PELAGIC</b>	Living or occurring in the open ocean.
<b>PHOTOSYNTHESIS</b>	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.
<b>PHYTOPLANKTON</b>	Algae, usually microscopic, which freely drift in the sunlit portions of the water column.

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<b>PLANKTON</b>	Drifting aquatic plants and animals; the adjectival form of plankton is planktonic, and a planktonic organism is called a plankter.
<b>POLLUTION</b>	Harmful impact on the environment resulting from human activities.
<b>PREDATOR</b>	An animal that captures other animals for food.
<b>PREY</b>	An animal caught for food.
<b>PRODUCER</b>	An organism that makes its own food; an example of a producer is a green plant.
<b>RESPIRATION</b>	Process used by animals and plants to release energy from food; this process requires oxygen and releases carbon dioxide and water.
<b>SALINITY</b>	The amount of salt in the water. Measured in parts per thousand.
<b>SCAVENGER</b>	An organism that is an opportunistic feeder; scavengers usually include dead and decaying animal flesh in their diets.
<b>SIPHONOPHORES</b>	A siphonophore is a relative of jellies. It is a translucent chain of specialized parts, each of which carries out a unique function. Siphonophores can reach lengths of up to 95 feet or more!
<b>SIPHONS</b>	The feeding tubes used by some bivalves (clams and oysters) to filter plankton.
<b>SPECIES</b>	A population of plants or animals that are able to produce viable offspring with each other and not with other species.
<b>SYMMETRY</b>	Correspondence in size, form, and arrangement of parts.
<b>TENTACLE</b>	A slender, flexible appendage.
<b>TIDES</b>	The daily rise and fall of the sea level along a shore, occurs twice a day on our local shores.
<b>TUBE FEET</b>	In echinoderms, hollow appendages filled with water and operated by the water-vascular system. Used for attachment, movement and the capture of water.
<b>VERTEBRATE</b>	An animal with a backbone. The back bone can be made of bone or of cartilage like in some fish (sharks and rays).
<b>VIVIPAROUS</b>	Reproductive strategy where mothers bear young that are nourished through a placental attachment (live birth).
<b>WATER-VASCULAR</b>	A system of canals, bulbs and appendages filled with sea water. This system is involved in locomotion in echinoderms.
<b>ZOOPLANKTON</b>	Animal plankton.

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## 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.

### ANIMAL ADAPTATIONS

Have your class research and discuss how marine animals protect themselves from their predators or what adaptations they have to become better predators. Have the class team up in small groups and be responsible for researching one phylum. Within each group, each student can choose one animal from this phylum. They can use books or any other resources to put together a report.

### SCIENTIFIC CLASSIFICATION

Demonstrate the meaning of scientific classification by having students categorize inanimate objects according to their own framework. You could use fruit, or something ordinary such as different kinds of nails (wood, standard, aluminum, galvanized, ringed, headless), to each small group. Have them categorize and then share their results with each other to start a general discussion on classification. Do we need it? Is any one type of classification better than another? Is there a benefit to sticking to one standardized system of classification?

### 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.

### Activities/Curriculum links:

<https://coast.noaa.gov/estuaries/curriculum/>

## POST-VISIT ACTIVITIES

### AQUARIUMS

Set up an aquarium in your classroom. All you need is a small aquarium, an undergravel filter system, an air pump connected to a bubbler, and fish or invertebrates. Most aquarium stores can direct you, or ask us at MSI. Students can watch the fish as they move their gill openings. How many times do they "breathe" per minute? Have your class figure out what the animals need to survive: food, water changes, oxygen, etc.

### ACTIVITY #1: Creative Classification

#### Objective:

To create an animal by using physical characteristics to categorize that animal in a classification system.

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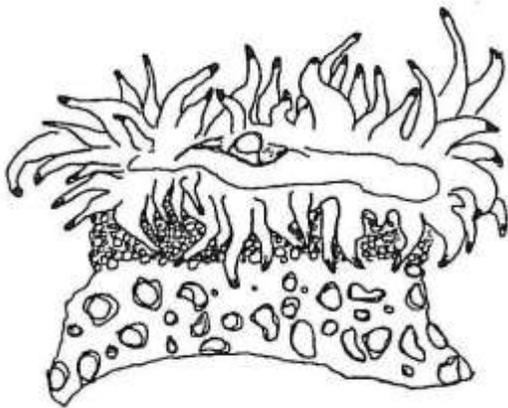
### You will need

- Clay
- Paper
- Markers

### Procedure:

1. Each student chooses a phylum, class, order, and family in the animal kingdom after which to model their animal. Write down main characteristics. You may want to limit choices.
2. Separate clay into medium sized balls.
3. Give time to design an imaginary animal following the main characteristics of the chosen phylum, class, order and family.
4. Name animal with an original genus species name. Genus is a larger group for similar species. Species category is for organisms with similar structures.
5. Compare “new critters” to the others in the same families.
6. Discuss differences between animal characteristics, habitats, and diets that create *biodiversity*.

**NOTE:** You may change this lesson by asking the students to create an animal based on the physical parameters of a given habitat. They can use the same materials and assign their critter a genus & species name as before!



Anthopkura  
Elegantrissima

## **ACTIVITY: Rocky Shores Creature Feature**

### **Objective:**

The objective of this activity is to familiarize and excite students about the creatures that live at the rocky shores.

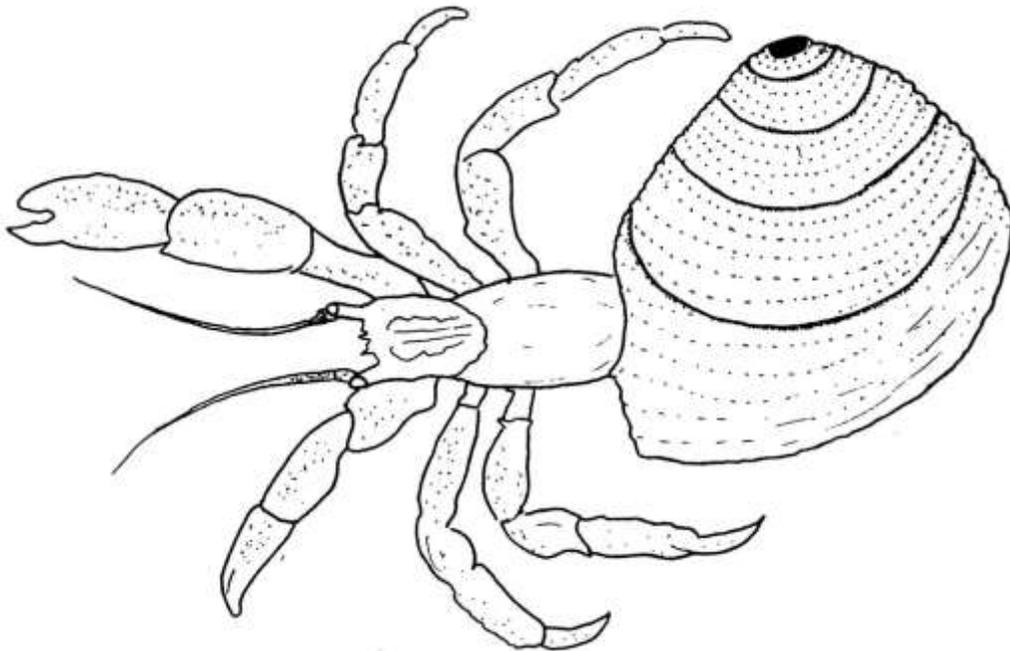
### **Procedure:**

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 rocky intertidal 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.



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# ROCKY SHORES CREATURE FEATURE



## Turban Snail

**Description:** Their shell can be brown or black with a spiral coiling shell. The snail's soft, muscular foot is black on the sides.

**Food:** It scrapes algae off rocks with a texture tongue, called a radula.

**Predators:** Shore birds, fish, crabs, other snails, and humans.

**Zone:** Found in the middle to low intertidal zone.

**Fun Facts:** The black turban is one of the best

## Acorn Barnacle

**Description:** Barnacles are white and volcano shaped. They glue themselves to rocks, pier pilings, whales, and ships.

**Food:** Plankton and particles suspended in water.

**Predators:** Their enemies include worms, snails, sea stars, fish, shorebirds, and oil spills.

**Zone:** They live in colonies in the high and middle intertidal zones.

**Fun Facts:** When submerged, they stick out

## Purple Sea Urchin

**Description:** Urchins have round shells with short spines. Its body is reddish to purple. Juveniles are pale green. They often burrow into rocks.

**Food:** They are herbivores that graze on algae.

**Predators:** Their predators include sea otters, fish and humans. Pollution is also a threat to urchins.

## Ochre Star

**Description:** These stars have rows of white tipped spines covering the back. They are rough to the touch. The color may be purple, brown, orange, red or yellow.

**Food:** Mussels, barnacles and certain snails.

**Predators:** Shorebirds and humans

**Zone:** They live in middle to low intertidal zones.

**Fun Facts:** This sea star needs only a 0.1 mm

## California Mussel

**Description:** The mussel is a black bivalve. It attaches to rocks by secreting a liquid that quickly hardens to form strong threads.

**Food:** Detritus, living plankton.

**Predators:** Ochre stars and humans

**Zone:** Found in dense colonies on wharf piles and surge exposed rocks in the middle to high intertidal zone.

## Nudibranch

**Description:** Soft body - not protected by a shell. The color is orange on the back with bright light blue lines. They have their gills on their back.

**Food:** Small sea anemones, worms, small crustaceans, tiny clams and even dead animals.

**Predators:** Few animals eat slugs because of their brightly colored warnings. The exceptions are sea hares, inexperienced fish and people.

## Purple Shore Crab

**Description:** These are a dark wine color with purple spots on their claws.

**Food:** It is a scavenger and eats dead plants, detritus, or small animals.

**Predators:** Fish, sharks, and shorebirds.

**Zone:** It is found in the high intertidal zone.

**Fun Facts:** They use camouflage and their claws for defense. They also hide under rocks. Gently

## Giant Green Anemone

**Description:** The column is olive green and the tentacles and disc are emerald green. The column is covered with wart-like tubercles.

**Food:** These animals use their stinging tentacles to catch detached mussels, crabs, sea urchins and small fish.

**Predators:**

**Zone:** zone.

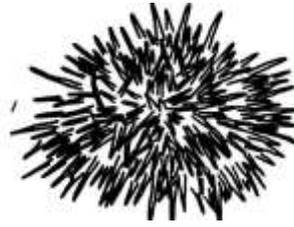


Acorn Barnacle



Ochre Star

*Pisaster ocraceus*



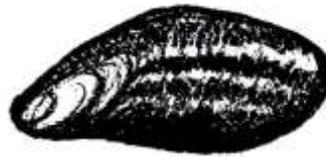
Purple Sea Urchin

*Strongylocentrus purpuratus*



Sea Slug

*Hemissenda crassicornis*



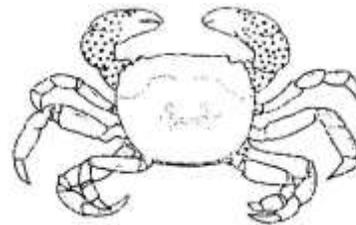
California Mussel

*Mytilus californicus*



Giant Green Anemone

*Anthopleura xanthogrammica*



Purple Shore Crab

*Hemigrapsus nudus*

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### **TURN YOUR CLASSROOM INTO A BAY**

Put blue paper around the classroom and have the students draw in various plants and fish, or have them cut out pictures of marine creatures to put on the blue paper. Let them put some benthic invertebrates on the bottom and plankton on the top!

### **MOBILES**

Let the kids make mobiles of the fish they saw. Take a hanger, some string, some cut-out drawings or pictures of fish and have fun! Attach the fish to the string. Then attach the string at varying lengths to the hanger. Be creative, use pictures of plankton and benthic critters. Possibly take two copies of the fish, glue the edges together, and stuff with some already used paper (recycle it!) and have a 3-D mobile. Older groups can make mobiles in the form of a food chain.

### **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.

### **Activities/Curriculum links:**

<https://coast.noaa.gov/estuaries/curriculum/>