

Dear Teacher:

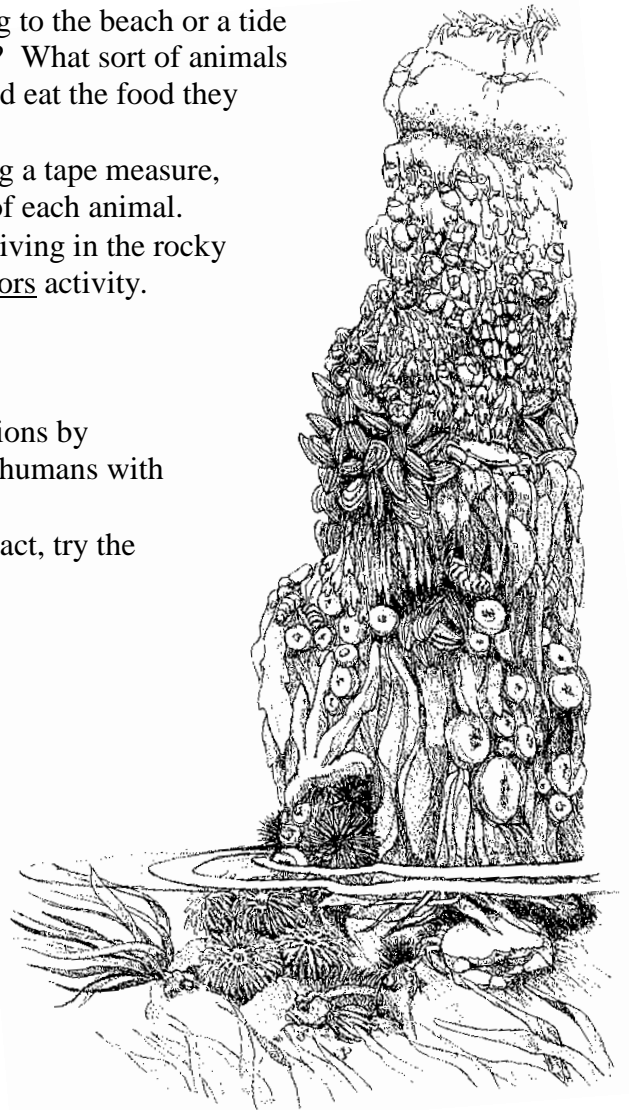
During the **From Tubefeet to Tentacles** assembly program an Aquarium educator will introduce students to the rough environment of the rocky intertidal zone using a PowerPoint presentation and bright, colorful costumes of animals like octopus and sea stars. This program will focus on some of the unique adaptations of five marine invertebrates: barnacles, sea stars, sea urchins sea anemones and octopuses. Students will compare their own adaptations to those of these amazing animals.

Before your assembly program:

- Ask students of their experiences with going to the beach or a tide pool. Was it a sandy beach or rocky beach? What sort of animals lived there? How do you think they find and eat the food they eat?
- Conduct the How Big Am I? activity. Using a tape measure, have your students measure out the length of each animal.
- Learn about the challenges and benefits of living in the rocky shore habitat with the Rocky Shores Survivors activity.

After your assembly program:

- Review several marine invertebrate adaptations by comparing them to tools made and used by humans with Tools of the Trade.
- To begin discussions on environmental impact, try the enclosed Dilemma Cards.



Participating in this program and using the pre and post curriculum will help your students meet Oregon science standards and Ocean Literacy Principles.

From Tubefeet to Tentacles assembly program: Grades 3-5

Goal: To familiarize students with rocky intertidal invertebrates found off the Oregon coast and their adaptations that help them to survive in this environment.

Cognitive Objectives:

1. Explain where the rocky intertidal zone is found.
2. Name three factors (waves, tides, predators) that affect an animals survival in the rocky intertidal zone.
3. Explain that adaptations are body parts that help intertidal invertebrates live in this environment.
4. Compare and contrast how a barnacle, sea star, urchin, sea anemone, and octopus protect themselves, eat and move.
5. Explain the appropriate adaptation of a specific rocky intertidal animal for a given environmental stress and how it works.
6. Describe how human behavior can affect the rocky intertidal zone.

Affective objectives:

1. Students will value the rocky intertidal zone as an important ocean ecosystem.
2. Students will feel that their stewardship of the rocky intertidal is important for its survival.

Oregon Science Standards:

- 3.1 Structure and Function: Living and non-living things vary in their characteristics and properties.
- 4.1 Structure and Function: Living and non-living things can be classified by their characteristics and properties.
- 5.2L.1 Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.

Ocean Literacy: Essential Principals and Fundamental Concepts

5. THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS.

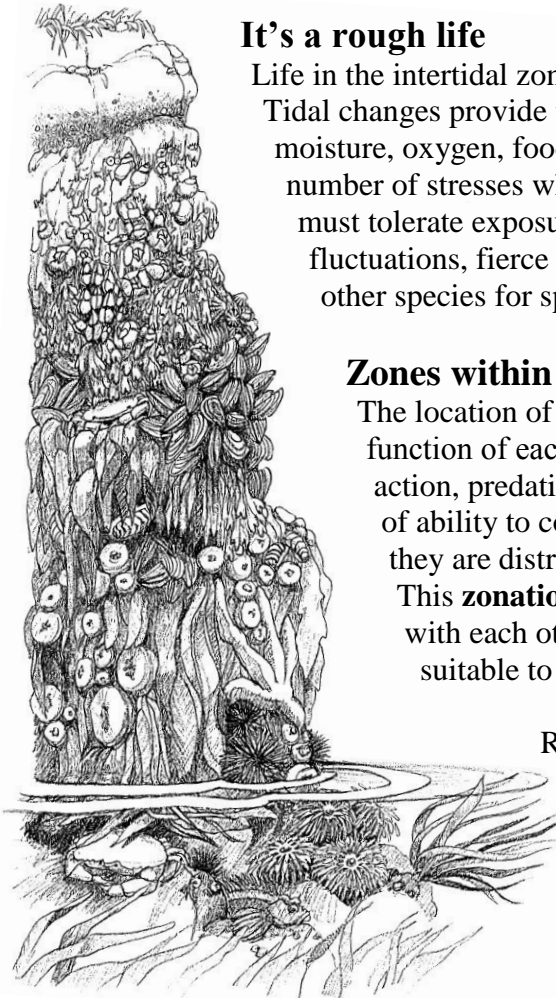
Rocky Intertidal Zone Background Information

The rocky intertidal zone

Twice a day along the Oregon coast, the tide comes in and the tide goes out as the sun and moon exert a gravitational pull on the earth's oceans. During low tide a large portion of the shore is exposed. This area between the high tide line and the low tide line is called the **intertidal zone**.

Oregon's rocky intertidal zone is an abundantly rich, temperate habitat. This is because the region's mild winters leave no threat of ice or prolonged freezing, and because summer's coastal fogs shade organisms from the hot sun. Also, plants of the intertidal zone, such as phytoplankton and seaweeds, are supplied with ample amounts of nutrients by the seasonal upwelling of deep sea waters.

This rocky intertidal environment is a conglomeration of crannies, crevices and tide pools that provide an incredible variety of habitat. This diversity of habitat insures a diversity of species, both animal and plant.



It's a rough life

Life in the intertidal zone is by no means a quiet, peaceful existence. Tidal changes provide these organisms with the basic necessities of moisture, oxygen, food and waste removal. But they also create a number of stresses which must be overcome. Organisms living here must tolerate exposure to air and sunlight, temperature and salinity fluctuations, fierce wave action, predation and competition from other species for space.

Zones within zones

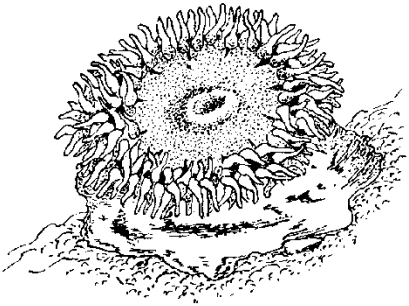
The location of plants and animals within the intertidal zone is a function of each species' ability to cope with exposure, wave action, predation and competition for space. Because the level of ability to cope with these factors is different for each species, they are distributed along the shore in distinct bands or zones. This **zonation** is a result of plants' and animals' interactions with each other and the environment to find the niche most suitable to their basic needs of food and shelter.

Remember, we have an impact on this fragile ecosystem. When tidepooling, watch where you step and always return animals, seaweeds and rocks to the place and position you found them.

Plants and animals of the rocky intertidal zone

Although some fishes are found in this area, the most abundant animals living here are **invertebrates**. Some common invertebrates found here are crabs, sea stars, sea anemones, sea urchins, snails, chitons, mussels and barnacles.

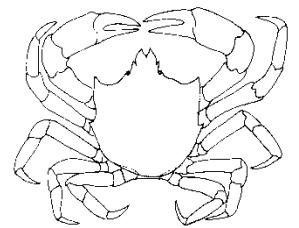
All of the animals living in the intertidal zone have developed **adaptations** – physical characteristics and behaviors – that enable them to survive in this rough-and-tumble environment. Some organisms are flat; some close themselves up; some hold on tight and some go with the flow. Some animals change color to avoid predators and some have built-in defenses.



To insure survival, each species has unique ways of defending itself, of reproducing, of feeding and of hiding. Most organisms rely on a combination of several adaptations to secure their place in the rocky intertidal. For example, spindly-legged kelp crabs cling to seaweeds to keep from being washed away with the current, and some cover their exoskeletons with seaweed to hide from predators. Kelp crabs are also often the color of the seaweed they live on.

Snails and limpets have hard shells to protect their soft bodies and a very strong foot to hold on tight in the crashing waves. Sea anemones have soft, flexible bodies to move with the flow of water, and tentacles covered with stinging cells to capture and stun their prey.

Seaweeds also are abundant in the intertidal zone, where they can get plenty of sunlight and also provide a rich habitat for many of the animals living there. Like animals, seaweeds must be adapted for survival in this environment. Some, like coralline algae and sea lettuce, are short and live in shallow water with tiny holdfasts securing them to rocks. Others, like many kelps, have long, flowing fronds that spread out across the rocks, absorbing sunlight and shading invertebrates. Most are flexible, like sea palms, and bend with the push and pull of the waves. Seaweeds come in a variety of shades of green, red and brown. They provide similarly colored animals with a place to hide and find food.



How Big Am I?

Lesson at a glance: Students will measure out the maximum lengths of a variety of ocean animals.

Oregon Content Standards:

SCIENCE

- **Third Grade:** 3.1 Structure and Function: Living and non-living things vary in their characteristics and properties.
- **Fourth Grade:** 4.1 Structure and Function: Living and non-living things can be classified by their characteristics and properties.
- **Fifth Grade:** 5.2L.1 Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.

OTHER ADAPTABLE CONTENT AREAS

- Mathematics

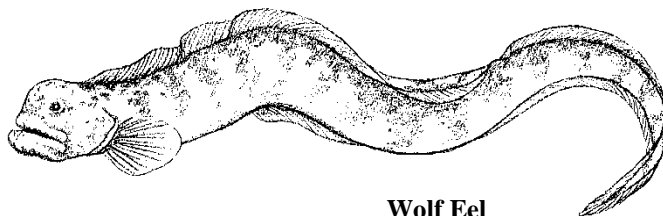
Ocean Literacy: Essential Principles and Fundamental Concepts

5. THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS.

- 5.a. Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.

Materials:

- ❑ Two 60-foot lengths of clothesline
- ❑ Cable ties
- ❑ Laminating materials
- ❑ Permanent markers
- ❑ A measuring tape for each small group of students
- ❑ Two copies of the attached animal pictures with their lengths.



Wolf Eel

Animal	Length
Lined hermit crab	¾ inch
Ochre star	12 inches
Tufted puffin (wingspan)	36 inches
Sunflower star	52 inches
Wolf-eel	5 feet
Leopard shark	6 feet
Brown pelican (wingspan)	7 ½ feet
California sea lion (adult male)	8 feet
Killer whale (adult male)	26 feet
Whale shark	46 feet
Gray whale (adult female)	49 feet
Sperm whale (adult male)	65 feet

Activity:

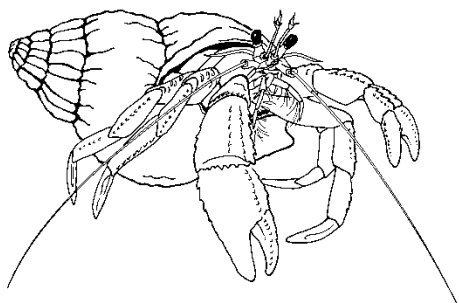
1. Before class, cut apart the pictures, laminate them (this should prevent them from tearing when they are attached to the rope), and punch a hole near the top for attachment to the rope.
2. Divide your class in half (each half will be working with a separate rope).
3. Divide the students from each half into groups of two or three.
4. Give each small group a laminated, punched picture and a marking pen.
5. Ask each small group of students to measure out the length of their animal, all using the same end of the clothesline as a starting point.
6. When they reach their point on the clothesline, have them mark it with a permanent marker and then attach their picture with a cable tie.
7. Ask each small group of students to stand at the length of their animal.

Summary:

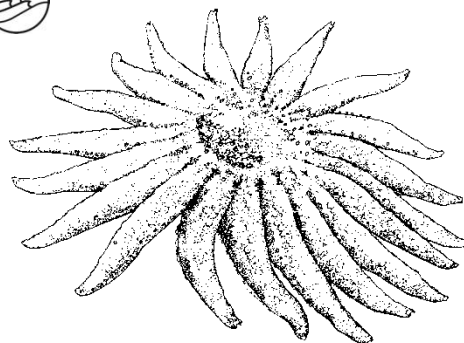
- Have the students share with their classmates the name of their animal and how long it is.
- Did the two sets of measurements match? Why or why not? Relate this question to why scientists do the same experiment many times before they are satisfied that the results are accurate.
- Have the students record how many of their footsteps equal the various lengths.
- Have your students design a bar graph with all of the animals.

Extensions:

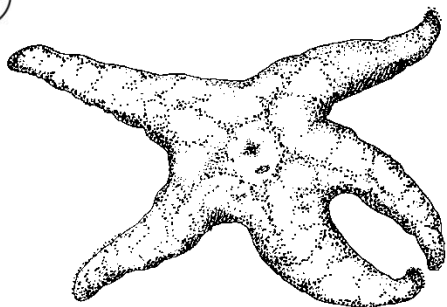
- Have the students write a research report on their animal. Have them include where their animal lives, what and how it eats, and other interesting information. Have them share it with the class.
- Once the animals are researched, have the students create a mural showing where their animals live. Use the pictures again and create a food chain based on the research your students completed on food choices.
- Have your students measure their height. How many of them does it take to equal the length of a wolf-eel, a killer whale, a gray whale or a leopard shark? How many hermit crabs would it take to equal their height?



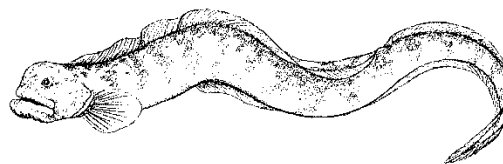
Lined hermit crab (3/4 inch)



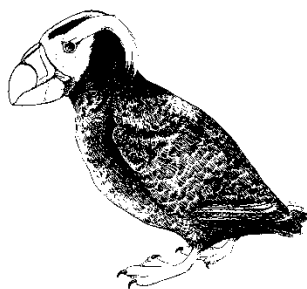
Sunflower star (52 inches)



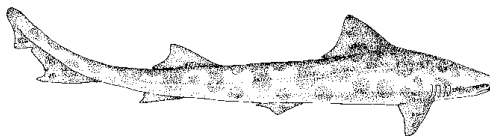
Ochre star (12 inches)



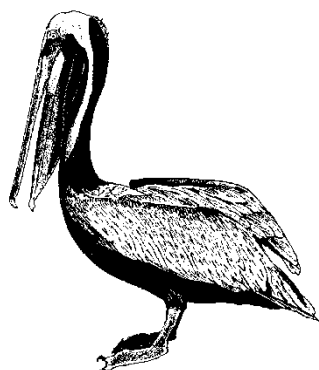
Wolf Eel (5 feet)



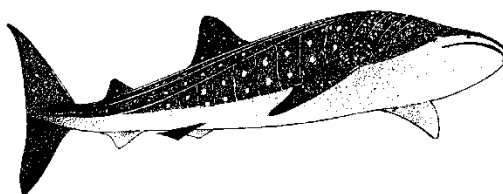
**Tufted puffin (36 inches)
(wingspan)**



Leopard shark (6 feet)



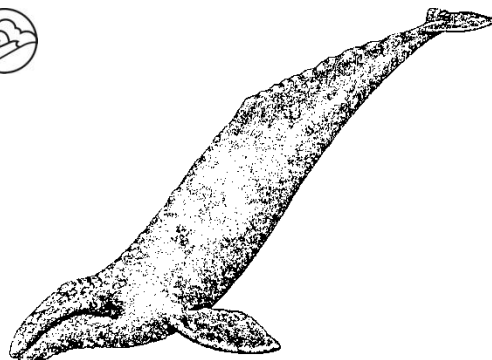
Brown pelican (7 ½ feet)
(wingspan)



Whale shark (46 feet)



California sea lion (8 feet)



Gray whale (49 feet)



Killer whale (26 feet)



Sperm whale (65 feet)

Rocky Shore Survivors

Lesson at a glance:

Students will learn about the challenges and benefits of living in the rocky shore habitat and the adaptations that rocky shore animals have to help them to deal with their constantly changing environment. Students will become intertidal organisms and role play various adaptations used for survival during both low and high tide.

Oregon Content Standards:

Science

- **Second Grade:** 2.1L.1 Compare and contrast characteristics and behaviors of plants and animals and the environments where they live.
- **Fourth Grade:** 4.2L.1 Describe the interactions of organisms and the environment where they live.
- **Fifth Grade:** 5.2L.1 Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.

Ocean Literacy: Essential Principles and Fundamental Concepts

5 . THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS.

- 5.d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.
- Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.

Materials:

- ❑ **Rocky Shore Resident** cards
- ❑ Large blue bed sheet or tarp
- ❑ Pillows (to be used as rocks)
- ❑ Masking tape, string or traffic cones (to mark off zones)

Background:

On the rocky shore, animals live in certain zones depending on their ability to withstand environmental pressures during both low and high tides. Zones include the **spray zone** (nearest to shore), **high tide zone**, **mid tide zone**, **low tide zone** and **subtidal zone** (the area never uncovered, even during the lowest low tide of the year). The area of the rocky shore that is between the edge of the low tide zone and the spray zone is called the **rocky intertidal zone**. When the tide is completely out (at low tide) in the rocky intertidal zone habitat, you will find pools of water left behind in the rocks. These are referred to as **tide pools**. What you find in a tide pool will depend on the depth of the tide pool and where it is located within the rocky intertidal area.

Rocky intertidal zones:

Spray zone

- The area just beyond the highest high tide
- Kept wet by salt water spray
- Flooded with water during storms
- Inhabitants include barnacles, snails and limpets

High tide zone

- Uncovered most of the time, except at high tide
- Hit by crashing waves at high tide
- Inhabitants include barnacles, snails, limpets, shore crabs and clingfishes
- Seaweeds include rockweed and sea moss

Middle tide zone

- Exposed to air twice a day during low tides
- Crashing waves occur as tide comes back in
- Inhabitants include mussels, snails, limpets, ochre sea stars, hermit crabs, gooseneck (leaf) barnacles, chitons, anemones (giant green and pink-tipped – *note*: other common names for the pink-tipped anemone are elegant anemone and aggregating anemone), sponges, tube worms, ribbon worms, porcelain crabs, red rock crabs and sculpins
- Seaweeds include surf grass, sea palm, coralline algae (pink in color, resemble coral)

Low tide zone

- Occasionally exposed to air during low tides
- Covered by water most of the time.
- Crashing waves as the tide comes back in
- Close to the edge of the water, even when uncovered
- Inhabitants include snails, limpets, chitons, red sea cucumbers, purple sea urchins (occasionally red as well), nudibranchs (sea slugs), sunflower sea stars, sponges, brittle stars, blood stars, six-rayed stars, shrimps, kelp crabs and tunicates.
- Seaweeds include feather boa kelp, sea lettuce, surf grass, oar weed (also called *Laminaria*)

Subtidal zone (nearshore seafloor, also referred to as the surf zone)

- Always covered by water
- Constant surging current
- Varying degrees of wave action depending on seasons and weather
- Inhabitants include all the animals listed in the zones above, various small fishes (also found in tide pools) including gunnels, sculpins, clingfish, snail fish, decorated warbonnets, monkeyface pricklebacks and wolf-eels. Red octopus, giant Pacific octopus and abalone are also found in rocky subtidal areas and tide pools.

Organisms found in this habitat are among the toughest in the survival business. This is because the conditions of their habitat changes throughout the day.

At LOW TIDE organisms experience:

Challenges

- Exposure to air
- Exposure to sun
- Exposure to rain or snow
- Land and air predators

Benefits

- None really

At HIGH TIDE organisms experience:

Challenges

- Crashing waves
- Strong currents
- Aquatic predators

Benefits

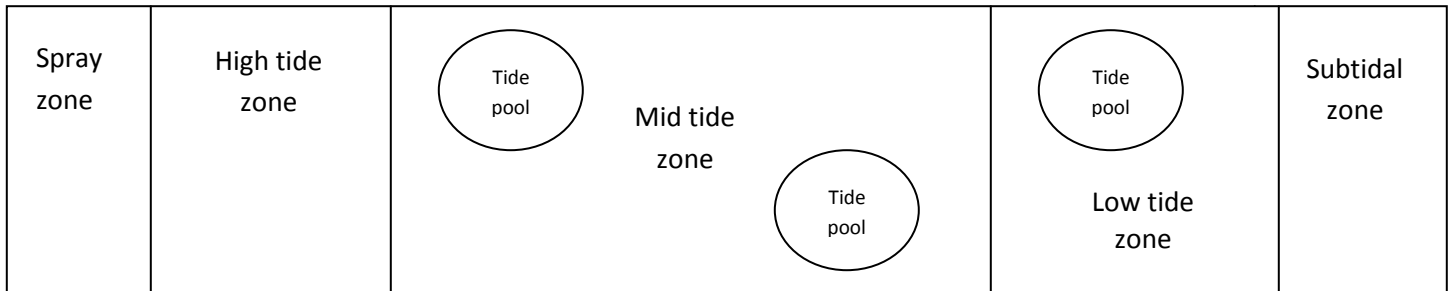
- Incoming food such as plankton
- Fresh, cold saltwater rich in oxygen

In addition to the challenges and benefits listed above, this habitat is also heavily populated with organisms, which makes food plentiful, but puts space at a premium.

Activity:

Preparation:

1. Copy and cut out the **Rocky Shore Resident** cards for your students.
2. Tape off an area on the floor that will be your rocky intertidal zone. If you have a large space available, such as a gym floor or grassy area, you should be able to have all of your students involved at once. However, if your space is limited to a hallway or part of your classroom, hand out just one of each of the Rocky Shore Resident cards to 18 of your students. Once the first 18 (or less, if you have a really small space) students has had their turn, have them rotate with the rest of the class.
3. Here is an example of what your rocky shore might look like:



4. Have pillows available for students to use as rocks to hold onto. A soft chair or couch might make a nice large rock.

Activity:

1. Introduce students to tides, the rocky intertidal zone habitat (including the location of each zone) and the challenges and benefits of life in this habitat.
2. Select four students to be the ocean. The ocean students will each be responsible for holding one corner of the bed sheet that represents the incoming and outgoing tide.
3. Assign each student a role by giving them a **Rocky Shore Resident** card. Each card will describe the organism they will play and the adaptations they have that deal with the challenges of their habitat. They will also find out how to reap the benefits of living in this bountiful environment.
4. Have students take their places in the appropriate zone. If an organism can be found in more than one zone then students can choose a zone to live in; however, they may notice that some zones are more crowded than others. Ask them to consider the advantages of living where it is less crowded (besides the fact that they may not want to be so close to their classmates).
5. Once they are standing in their zone, have each student share the following information with the class:
 - a. What kind of organism they are.
 - b. Why they live in the zone they do, or why they can live in several zones.
6. Once all the students have shared their information, have them assume a position appropriate to their organism. *Remind students that rocky shore*

residents are better off being low to the rocks to keep from being knocked off by a crashing wave.

7. Once students are situated, begin by telling them that it is low tide. No one should be moving at this time because they are either hiding from the sun, they don't have enough energy for much movement because of the low oxygen in their tide pool (if they are in a tide pool), or they are closed up to keep from drying out (such as anemones and barnacles).
8. Next, instruct the ocean students to slowly begin bringing the sheet up over the low tide zone. *Note:* The sheet should be held well above the rocky shore residents, unless you feel your students are mature enough to react appropriately to having the sheet touch them as a "crashing wave."
9. As the sheet covers the organisms, they should become more active. Sculpins should begin looking for food, anemones and barnacles should open up and begin to feed. Hermit crabs should also begin to scavenge.
10. Finally, instruct the ocean students to begin bringing the ocean away from shore.
11. Rocky shore residents should react appropriately to the receding tide.
12. Remind students of potential dangers as the tide goes in and out. For example, announce that a sea gull is about to land on the rocky shore and will certainly be looking for an easy sea star, snail or crab snack. At low tide, rocky shore residents should be on the lookout for octopuses, wolf-eels and other carnivorous fishes.
13. Provide opportunities for students to take turns describing the adaptive behaviors that they are acting out.
14. Repeat as often as you want. You may want to repeat the activity at least once so that the ocean wave students will have a chance to role play a rocky shore resident.

Summary:

1. Review the various challenges and benefits of living in the rocky intertidal zone and discuss the adaptations for survival found in rocky shore residents.
2. Discuss the effects humans have on this environment, such as fishing, harvesting (mussels and sea urchins) and tidepooling.

Extensions:

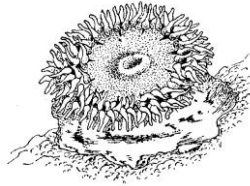
1. Have students research their own rocky shore resident and create cards using the blank templates included in this packet.
2. Visit some natural tidepools or an aquarium that exhibits rocky intertidal animals.

Organism

Green sea anemone

Zones

Mid, low and subtidal zones, and in tide pools

**Low tide adaptations**

- Bring in tentacles and close up to hold moisture in.
- Cover yourself with bits of shell and sand to shade yourself from the sun

High tide adaptations

- Open up, reaching your tentacles out to sting and eat incoming plankton.
- Bring plankton to your mouth in the center of your ring of tentacles.
- Hold on with your foot.
- Your soft body allows you to sway with the current

Predators

Some sea slugs (nudibranchs) might feed on your tentacles. The stinging cells stored in your tentacles don't seem to bother them. In fact, they keep them in their own body for protection from predators. However, if a careless slug falls into your ring of tentacles, you eat them.

Diet

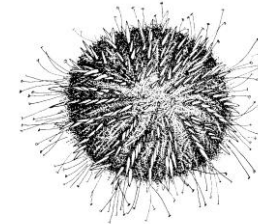
You eat plankton and any small fish or invertebrate that bumps into your stinging tentacles.

**Organism**

Purple sea urchin

Zones

Low tide zone and in tide pools

**Low tide adaptations**

Cover yourself with rocks and shells to shade yourself from the sun. Some sea urchins make a small hole in the rock to hang out in during low tide. Their hole is like a tiny tide pool. Staying under a rock ledge or some seaweed will also help keep you cool and moist.

High tide adaptations

Hold on tight with your tube feet so the crashing waves don't knock you off your rock. Put your tube feet out to catch any seaweed that may float by.

Predators

Sea otters, sea stars, octopus, crabs, bears, raccoons, sea gulls, wolf-eels and other fish all eat sea urchins. People will also harvest and eat sea urchins. All of these predators have ways to avoid being hurt by your spines, but many other animals will avoid eating prickly sea urchins.

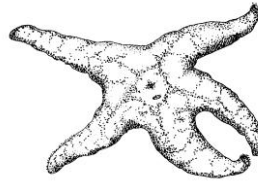
Diet

You eat mostly seaweed, but once in a while you'll eat a snail, chiton or limpet if you're hungry. You use five sharp teeth for eating.



Organism

Ochre sea star

**Zones**

Mid, low and subtidal zones, and in tide pools

Low tide adaptations

Use your tube feet to move into a tide pool or under a rock as the tide goes out. If you aren't able to do this before the tide is out, you will survive on an exposed rock, but you will get warm and dry, which may be uncomfortable. Use the light-sensing eye spots on the tip of each arm to help you sense predators

High tide adaptations

Hold on tight with your tube feet so the crashing waves don't knock you off your rock. Crawl around slowly looking for food. You can smell your food with your tube feet.

Predators

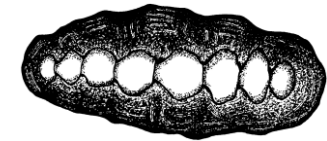
Sea otters, other sea stars, crabs, sea gulls, and fish all eat ochre sea stars. You have short, bumpy, white spines that cover your body. These spines make it difficult for many predators to eat you.

Diet

You eat mussels, snails, limpets and chitons. You eat your prey by holding onto its shell with your tube feet and inserting your stomach inside to digest the meat. You only have to open a mussel's shells as wide as a hair to fit your stomach inside. Your stomach comes out of your mouth and goes back inside when you are through eating.

**Organism**

Black katy chiton (*KIE-t'n*)

**Zones**

Mid, low and subtidal zones and in tide pools

Low tide adaptations

Hold onto the rocks tightly with your large foot. Your eight shell plates and thick skin will help you stay wet on the inside of your body until the tide comes back in.

High tide adaptations

Hold on tight with your foot to avoid being knocked off by big waves and strong currents. Move around slowly as you graze on seaweed growing on the rocks. You use a sharp tongue covered with teeth to get the seaweed off the rocks. Your tongue is called a radula.

Predators

Sea otters, sea stars, crabs, and fish all eat chitons. Your main protection against predators is that your dark color helps you to blend into the rocks and seaweed.

Diet

You eat seaweed. Seaweeds are also called algae (*AL-gee*).



Organism

Black turban snail

Zones

High and mid tide zones

**Low tide adaptations**

Hold on tight to a rock or the shell of another animal. Use your muscular foot to pull your shell so close to the rock that you can hold water inside your body until high tide.

High tide adaptations

Cruise around on the rocks to find a good patch of algae (seaweed) to munch on. Watch out for predators!

Your smooth, round shell allows waves to flow easily over your body, rarely knocking you off the rocks.

Predators

Sea otters, sea stars, crabs, sea gulls, black oystercatchers (a shore bird) other snails, and fish all eat black turban snails. Your shell protects you some, but the claws, beaks, tube feet and paws of your predators are designed for eating hard shelled animals like you.

Diet

You eat algae off the rocks using a sharp tongue called a radula.

**Organism**

Ribbed limpet

Zones

Spray zone and high tide zone – often in the shade.

**Low tide adaptations**

Hold on tight to a rock or the shell of another animal. Use your muscular foot to pull your shell so close to the rock that you can hold water inside your body until high tide.

High tide adaptations

You move around a little bit using your muscular snail-like foot. You have a sharp tongue called a radula that helps you to scrape algae off the rocks.

You don't feel much pressure from crashing waves because of your mountain-shaped shell.

Predators

Sea stars and meat-eating snails will eat limpets. However, you hold on so tight to the rocks that it is almost impossible to pull you off. You should be especially careful when you are moving and not holding on as tightly.

Diet

You eat algae off the rocks using a sharp tongue called a radula.

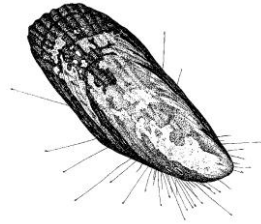


Organism

Mussel

Zones

Mid, low and subtidal zones

**Low tide adaptations**

Mussels have two shells protecting their soft bodies from predators, dry air and the hot sun. During low tide you will slowly open and close your shells to cool yourself off. However, you should open your shells a only tiny bit, because you don't want to dry out.

High tide adaptations

Mussels make special threads called byssal threads that attach to rocks or other mussels so that they aren't swept away by the waves and currents. Your round, smooth shell allows waves to flow over you easily so that you are less likely to be torn off the rocks.

Predators

Sea otters, sea stars, octopuses, crabs, sea gulls, black oystercatchers (a shorebird), wolf-eels and other fish all eat mussels. Your hard shell protects you a little bit, but your predators know how to break your shell open.

Diet

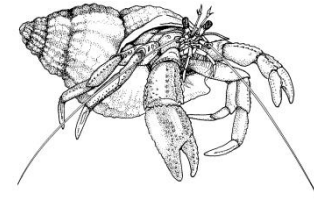
You eat plankton by pulling it into your body using a siphon. A siphon is a lot like a straw. You pull water in and filter out the plankton inside your body and they send the water back out again.

**Organism**

Hermit crab

Zones

Mid, low and subtidal zones, and in tide pools

**Low tide adaptations**

Find a tide pool as the tide goes out. You'll hang out in your tide pool, hiding in the seaweed or in cracks in the rock. The tidepool water will get warmer as the hours go by before the tide comes back in, but you do your best to breathe and stay safe from predators. You may even find a snack or two if you have the energy .

High tide adaptations

Get movin'! The cold water feels good and you go out looking for food or maybe a new snail shell to wear. Be careful, though, because if you take off your shell for too long you'll make an easier meal.

Predators

Sea otters, sea stars, crabs, octopuses, sea gulls and fish all eat hermit crabs. If a predator tries to grab you, you can pull your body into your shell and use your big claw to seal the entrance.

Diet

You eat whatever you can find, whether it's alive or already dead. You eat seaweed and the leftover tidbits left behind by other animals.

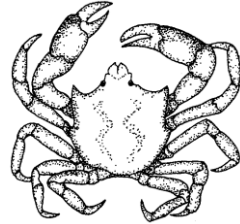


Organism

Kelp crab

Zones

Mid, low and subtidal zones
and in tide pools

**Low tide adaptations**

You hide out in tide pools or under piles of seaweed covering the rocks. You stay fairly cool and wet until the high tide comes back in.

High tide adaptations

Hold on tight to the kelp (large seaweed) as the currents and crashing waves hit the rocks. Your long spiderlike legs and strong claws help you to hold on.

Predators

Sea otters, sea stars, crabs, sea gulls, and fish all eat kelp crabs. The adaptation that helps you the most is that your body is the color of the kelp that you live in. This camouflage makes it very difficult for predators to find you. You also give quite a pinch with your claws!

Diet

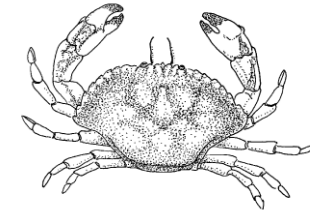
You eat kelp, but you'll also eat small animals such as shrimp. You also don't mind eating scraps of food left behind by other animals.

**Organism**

Red rock crab

Zone

Low and subtidal zones, and in
deep tide pools

**Low tide adaptations**

You hide under rocks and seaweed in the tide pools, usually far from shore. Before the water gets too warm and there is less oxygen to breathe, you may even have time to do some scavenging for food.

High tide adaptations

Hold on tight with your strong legs and claws. You may want to wedge your body into a crack in the rocks so that you don't get swept too far away from the tide pools. You don't mind living offshore, though, as long as there is still plenty to eat.

Predators

Sea otters, other crabs, sea gulls, wolf-eels and octopuses all eat red rock crabs. Your shell and strong claws make it hard for many animals to eat you, but if they can't eat you while you're alive, they'll have a feast after you've died.

Diet

You eat mussels, snails, limpets, chitons, other crabs, shrimp, and small octopuses. You are one of the faster rocky shore residents and can catch almost anything except for a quick swimming fish. You also like to scavenge and eat dead animals or the scraps left behind by others.

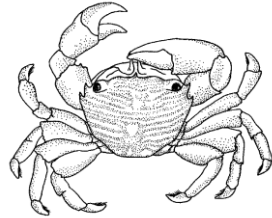


Organism

Purple shore crab

Zones

High, mid, low and subtidal zones and in tide pools

**Low tide adaptations**

Sometimes you might hang out in a tide pool, but you are really good at staying out of the water during low tide as long as you are sheltered by a rock or some seaweed. You need to stay out of the sun so that you can keep your gills wet and keep breathing. Your flat body helps you squeeze under rocks or into small cracks. These are also good places to hide from predators.

High tide adaptations

You might want to stay under your rock or in your crack in the rock, so that you are less likely to be swept away by strong waves and swirling currents. However, you do need to come out to eat, and this is when you'll be on the look out for predators.

Predators

Sea otters, other crabs, sea gulls, and fish all eat shore crabs. Your exoskeleton (shell) protects you from some animals, but your main predators have adaptations to help them break through your shell.

Diet

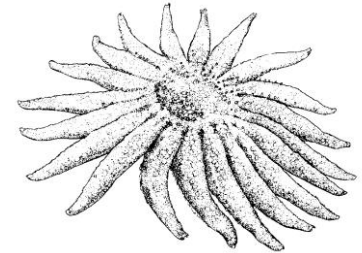
You eat algae and leftover scraps of food left behind by other animals.

**Organism**

Sunflower sea star

Zones

Low and subtidal zones, in deep tide pools

**Low tide adaptations**

You need to stay under water to be able to move, so you want to stay in a large tide pool, far from shore. You can be found in bays far off shore, but you like the tide pools because there is lots of food there. You'll move closer to shore as the tide comes back in.

High tide adaptations

Use your tube feet to move along the rocks looking for food. You can smell your prey with your tube feet.

Predators

Sea otters, other sea stars, crabs, sea gulls, and fish all eat sea stars. You have short, bumpy, white spines that cover your body. These spines make you less appetizing, but you still might get eaten, especially when you are small.

Diet

You eat mussels, snails, limpets, other sea stars, sea cucumbers, sea urchins, chitons, crabs and shrimp. You are one of the faster rocky shore residents and you can eat just about any animal that is slower than you are. You will also eat animals that have already died.



Organism

Red sea cucumber

Zones

Low and subtidal zones

Low tide adaptations

You stay far from shore so that you are always covered with water. You wedge yourself into cracks in the rocks and hide from land and air predators such as bears and sea gulls.

High tide adaptation

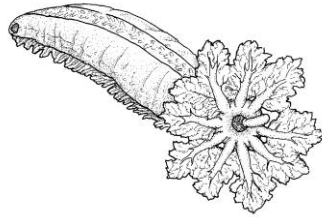
Stay in your rock crevice, so that you are not swept out of the rocks into an area where a predator might easily spot you. High tide is meal time for you. Open up your ten bright orange, sticky feeding branches and begin to catch plankton as it floats by. When a feeding branch is covered with food, push it into your mouth, which is in the center of your feeding branches. It looks like you are licking your fingers.

Predators

Sea otters, sea stars, crabs, sea gulls, and fish all eat cucumbers. Even though you are related to sea stars and sea urchins, your body isn't spiny, so you are an easy meal if you are not hidden.

Diet

You eat plankton as it drifts by during high tide.

**Organism**

Tidepool sculpin

Zones

Mid and subtidal zone tide pools

Low tide adaptations

You try to stay in the same tide pool all of the time, so make sure you are there when the tide goes out. While the water is still cool, you hunt for food. As the water warms up, and as long as the tide is out, you slow down to rest and do your best to get enough oxygen to breathe.

You blend in very well to the rocks and seaweed at the rocky shore.

High tide adaptations

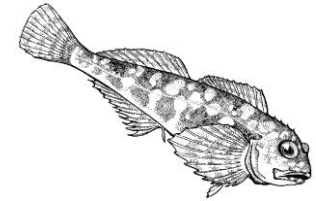
This is a great time to look for food, but larger fish have come in with the high tide, so you had better be on the lookout for predators.

Predator

Crabs and larger fish eat sculpins. You have spines on your dorsal (back) fin that protect you from some predators. But you are very small and fit into the mouths of many other fish.

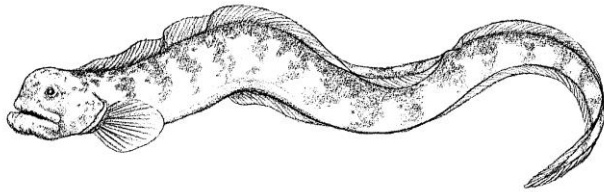
Diets

You'll eat the legs off of a barnacle or scavenge for the leftover meals of other animals.



Organism

Wolf-eel

**Zones**

Subtidal zone

Low tide adaptations

Stay out of the low, mid and high tide zones! You are a big fish that can grow to be seven feet long. You don't want to be trapped in a tide pool at low tide, because there won't be enough space or oxygen for you.

High tide adaptations

You feed mostly in the subtidal zone, but you will visit the zones closer to shore in search of food.

Predators

When you are young, many larger fish will eat you. As you grow larger, you will have fewer predators. A hungry octopus or harbor seal or shark might consider eating you if you are away from the safety of your rocky den.

Diet

You eat mussels, snails, sea urchins, crabs, sea cucumbers and shrimp. Your powerful jaws and mouth full of crushing molars help you to eat your hard-shelled prey. You will eat most of your food shell and all!

**Organism**

Acorn barnacle

**Zones**

High and mid tide zones

Low tide adaptations

You live inside a volcano-shaped shell that you've built yourself. You have four shell plates at the opening of your shell that you keep tightly closed at low tide. You hold water inside your shell at low tide to keep from drying out. You get pretty warm if the sun is out, but most barnacles usually make it until the tide comes back in. Barnacles can stay out of the water longer than most rocky shore residents, which means you can take advantage of all the living space in the high tide zone.

High tide adaptations

You are glued on your head to a rock or shell. This keeps you from being swept away by crashing waves or strong currents. The shape of your shell allows water to flow around you easily. High tide is feeding time for barnacles.

Predators

Sea stars, crabs and small fish feed on barnacles.

Diet

You use your twelve feathery legs to sweep plankton from the water into your shell.

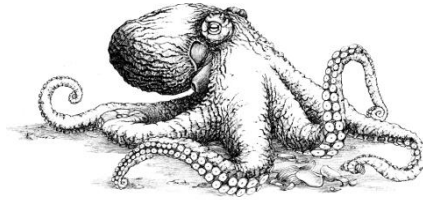


Organism

Giant Pacific octopus

Zones

Low and subtidal zones
and in tide pools

**Low tide adaptations**

When the tide is out you need to head out to the subtidal zone or find a tide pool to hang out in. You will also need to find a rocky cave where you can hide from prey and predators. Giant Pacific octopuses can grow to be over a hundred pounds, but many young octopuses will live in the tide pools when they are small and then move further away from shore as they grow larger.

High tide adaptations

This is a good time for you to come closer to shore to look for food.

Predators

A seal or shark would certainly like to take a bite of your soft body. However, if they only get an arm or two, you can grow them back later.

Diet

You eat snails, shrimp, crabs, and smaller octopuses.

**Organism**

Shag-rug nudibranch

Zones

Low and subtidal zones
and in tide pools

**Low tide adaptations**

Move into a tide pool or a shady area on the rocks. You blend in either place, since you aren't very colorful and look like a tiny gray mop.

High tide adaptations

Hold on tight to the rocks or find a crack in the rocks where the waves are not as strong. You prefer to live on rocky shores where the waves don't get very big.

Predators

Few animals will eat you even though you are small and soft. You aren't a very easy meal because of the stinging cells that you store in your body. You get the stinging cells by eating sea anemones.

Diet

You carefully feed on the tentacles of sea anemones. One false move and you might fall in and become a meal yourself!



Organism	Draw a picture of your organism:	Organism	Draw a picture of your organism:
Zones		Zones	
Low tide adaptations		Low tide adaptations	
High tide adaptations		High tide adaptations	
Predators		Predators	
Diet		Diet	



Tools of the Trade

Lesson at a glance:

Students will understand and recognize several marine invertebrate adaptations by comparing them to tools made and used by humans.

Oregon Content Standards:

Science

- **Third Grade:** 3.1 Structure and Function: Living and non-living things vary in their characteristics and properties.
- **Fourth Grade:** 4.1L.1 Compare and contrast characteristics of fossils and living organisms.
- **Fifth Grade:** 5.2L.1 Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.

Ocean Literacy: Essential Principles and Fundamental Concepts

5. THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS.

- 5.d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.

Materials:

- Marine invertebrate pictures and/or names on cards
- Human tools and other objects that represent marine invertebrate adaptations
- Blanket or sheet
- Table or floor space

Activity:

Note: This activity works best as a review of the adaptations learned by your students throughout your unit.

1. Gather a collection of tools and other objects that represent marine invertebrate adaptations.
2. Before class, place the items under a blanket or sheet on the floor or on a table.
3. Give each student a picture and/or name of a marine invertebrate.
4. Explain to students that they will be looking at man-made items that can be compared to some marine invertebrate adaptations. Some of the tools simply look like a specific adaptation (structure), while other tools actually serve a similar purpose (function) for humans as they do for the animal with the adaptation.
5. Have the students sit down in a circle around the covered items. Everyone must be able to see the blanket or sheet.
6. Lift the covering off the items and give students about five seconds to look at the items.
7. Quickly cover up the items.
8. Ask students to name an item that they saw that corresponds with an adaptation belonging to their assigned animal.
9. Pull out the items that the students identified.

10. Ask the student(s) holding the appropriate animal picture or name to describe why they think their animal has an adaptation that works like the tool.
11. Repeat the activity until all of the items have been seen and explained.

Comparison Examples:

Function (“works like a . . .”) and structure (“looks like a . . .”)

An **octopus’ beak** works like a **nutcracker** to crack open the shells of its prey. Octopuses eat crabs, snails, shrimps, mussels and other hard-shelled invertebrates.

Some molluscs, including snails, limpets, squids and octopuses, have a rough tongue called a **radula**, which works like a **file**. Octopuses and squids use their radula to scrape the flesh of their prey from their shells, while many snails and limpets use their radula to scrape algae off the rocks.

Invertebrates with **shells** benefit from the protection of their hard covering in many ways. It makes them more difficult to eat and also protects them from the harsh conditions of the environment such as crashing waves and rough rocky or sandy surfaces. Although humans have bones to protect internal organs and skin to protect us from diseases, we often engage in activities where we might need extra protection. **Helmets** should always be worn when riding a bike and **protective gear** is usually worn by football players. A **suit of armor** worn by a knight hundreds of years ago is similar to a crab’s exoskeleton – joints and all!

A barnacle has a thin exoskeleton covering its body, but that’s not quite enough, so it builds a **hard shell casing** to surround its entire body for extra protection. Its outer shell can be compared to a **stone castle** built to keep out the enemies of those who live within the castle walls.

Sea urchins have **five sharp teeth** (called Aristotle’s lantern) that they use to feed on kelp and other algae. However, some sea urchins can also use their teeth to scrape away at the rocks like a **chisel**, making a private tide pool where they are more protected from the crashing waves.

Most sea stars, sea urchins, sand dollars and sea cucumbers (the echinoderms) have **tube feet** to help them move, hold on and eat. Tube feet are soft, hollow tubes with a suction cup on the end. The suction cup can be compared to a **toilet plunger** or any other **man-made suction cup**; however, the tube foot structure actually works more like an **eyedropper** or **turkey baster** filled with liquid. It’s the water pressure within the tube and tiny bulbs at the top of the tube in the animal’s body that actually create the suction.

Octopuses, squids, cuttlefish and nautilus (the cephalopods) have **sucker discs** on the tentacles that help them to grab their prey. These discs can also be compared to the suction cup on a **toilet plunger**. Cephalopod suckers are different from tube feet because they rely on muscle contractions rather than water pressure for their suction.

Sea anemones, jellies and corals can sting with their **nematocysts**. Nematocysts are stinging structures used to capture food and for protection. A nematocyst looks a lot like a **harpoon** or **dart** at the end of a thread.

Crabs, lobsters and some shrimps have **claws** to grab, hold and crush their prey. People will use **tongs** to grab food and **nutcrackers** to crush food, including crabs and lobsters.

Octopuses and their cephalopod relatives have a **beak** shaped like a parrot's beak that they use to crush and tear apart their prey. Since they use this beak for cracking through the hard shells of their prey, the cephalopod beak can also be compared to a **nutcracker**.

A **barnacle's feathery legs** and a **sea cucumber's feeding branches** work like tiny **nets** to trap the plankton on which they feed. Barnacle legs look a lot like **eyelashes**.

Sea urchins, sand dollars and some crabs and shrimps have bodies covered with **spines** that make them a difficult meal for many predators. Sea urchin spines look and feel just like **toothpicks**.

Summary:

1. Discuss how organisms are born with the adaptations that they need to deal with most environmental pressures and that they cannot always keep up with changes made to their environment by humans. For example: Tidepool invertebrates haven't entirely adapted to being walked on by curious and often careless humans.
2. Have students brainstorm things that they can do at home to help protect the marine environment and its inhabitants.

Extensions:

1. Have students create their own marine animal adaptation analogies.
2. Introduce evolution and discuss the theory of natural selection to help explain how marine invertebrates came to have these adaptations.
3. Use this activity as an introduction to similes and metaphors in a Language Arts unit.

Tidepool Dilemmas

Lesson at a glance:

This lesson is designed to give students an opportunity to examine their own values and beliefs related to the environment and to practice discussing environmental issues without placing judgments.

Common Curriculum Goals and Benchmarks:

SOCIAL SCIENCE

- **Third Grade:** SS.03.CG.03 Identify ways that people can participate in their communities and the responsibilities of participation.
- **Third Grade:** SS.03.SA.03 Identify and compare different ways of looking at an event, issue, or problem
- **Third Grade:** SS.03.SA.04 Identify how people or other living things might be affected by an event, issue, or problem.
- **Third Grade:** SS.03.SA.05 Identify possible options or responses; then make a choice or express an opinion.
- **Fourth and Fifth Grade:** SS.05.GE.07 Understand how physical environments are affected by human activities.
- **Fourth and Fifth Grade:** SS.05.GE.07.02 Describe how human activity can impact the environment.
- **Fourth and Fifth Grade:** SS.05.SA.03 Identify and study two or more points of view of an event, issue, or problem.
- **Fourth and Fifth Grade:** SS.05.SA.04 Identify characteristics of an event, issue, or problem, suggesting possible causes and results.

Ocean Literacy: Essential Principles and Fundamental Concepts

6. THE OCEAN AND HUMANS ARE INEXTRICABLY INTERCONNECTED.

- 5.e. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

Materials:

- **Tidepool Dilemma** cards

Background information:

Discussing environmental ethics can be difficult. There are many sides to every issue, and often the feelings for one position or another are strong. In presenting this activity to students, stress the importance of not placing judgment, and listening to perspectives other than their own. Understanding all sides can provide a bigger picture of the issues. At the same time, lessons regarding stewardship towards organisms within their habitat should be discussed.

Activity:

1. Divide students into groups of four or five.
2. Give each group a dilemma card and have one member read the dilemma and the choices of answers to the rest of their group.
3. Each student in the group should decide on their own what their response would be. Then have each group discuss their choices among themselves. Each student should be able to defend his or her reasoning.

Summary:

Discuss each dilemma as a class. Be sure the final point is that there are several sides to any issue and usually there isn't one right answer. Stress the importance of gaining a clear understanding of all positions.

Extension:

Have students make up their own dilemmas regarding local or national issues.

Adapted from "Ethi-reasoning," *Project Aquatic Wild*.

1.

It's your first time visiting the tide pools and you are excited to find hundreds of little hermit crabs running around. You love hermit crabs! You've even got one at home that you bought at the pet store. His name is Herman. Lately, you've felt that Herman is lonely and you'd like to get him a friend. Your classmate suggests bringing one of these tidepool hermits home to Herman.

What should you do?



4.

You just found the coolest crab. It's different than anything you've ever seen before. It is about the size of your palm. It has thick, red claws with little black tips and its back is covered with red and white stripes. There are even tiny barnacles growing on its back. You pick it up and run over to show the rest of your class. They are all totally amazed by this little critter.

Now you're standing with this cool little crab in your hands; what should you do with it?



2.

While you are touring through the tide pools at a local state park you see a European green crab. You learned in class that the green crab is an invasive species. People accidentally carry invasive species into habitats where they don't belong. Sometimes invasive species can upset the balance of the ecosystem. You don't want that to happen—you love these tide pools.

What should you do?



5.

Your class is having a great time at the tide pools. While you are trying to peek up under a ledge looking for abalone you hear a friend call your name. He has the most amazing thing to show you. "My dad showed me this. When you poke one of these goopy green blobs, they squirt water!" Sure enough, when he pokes a green sea anemone, a stream of water squirts out. "Try it!" he squeals.

What should you do?



3.

Your class is visiting the most amazing tide pools you've ever seen. There are living things everywhere. You are being very careful not to squish anything when you walk. Suddenly, you hear shouting. A group of your classmates has found an octopus! The fastest way to get there is over a bed of mussels and barnacles. You don't want to step on them, but the octopus might be gone if you take the long way.

What should you do?



6.

It's your first time in the tide pools and you are learning a lot. While stepping carefully from rock to rock, you and your buddy find a sea star. Your friend tells you that sea stars have hundreds of tiny suction-cup tube feet that help them hold onto the rock, and a mouth right in the middle of its body—only underneath. You don't believe her. How will you find out if she's telling the truth?



4.

- a. Turn around and put it back right where you found it.
- b. Put it in the closest tide pool since they all seem the same to the crab and you want to get it back in the water fast.
- c. Take it back to your school and put it in an aquarium for everyone to enjoy.
- d. Feed it to that hungry sea gull that has been following you. After all, it's part of the circle of life, right?
- e. Other.

1.

- a. Put one of the little hermit crabs in your pocket and get him home as fast as possible.
- b. Leave the tidepool hermit crabs where they are, since they need water to breathe and wouldn't survive the trip in your pocket.
- c. Put the hermit under a rock and come back for him later with some water in a dish to transport him home.
- d. Scold your classmate severely for even suggesting such a thing.
- e. Other.

5.

- a. Tell him he's poking a sea anemone and that it needs that water to survive.
- b. Tell your teacher or chaperone about his behavior.
- c. Say no thanks and walk away.
- d. Poke him with a stick while screaming "HOW DO YOU LIKE IT!?"
- e. Other.

2.

- a. Do nothing. It's not up to you to deal with green crabs.
- b. Tell the park ranger or your teacher.
- c. Leave it, but decide to do a report on green crabs at school and share it with your community.
- d. Stomp it good.
- e. Other.

6.

- a. Leave the sea star where it is and ask your teacher if your friend is telling the truth.
- b. Smile and nod then check at the library later to see if she is right.
- c. Carefully pull it off the rock.
- d. Use a pocketknife to cut the suckers loose.
- e. Other.

3.

- a. Get over there as fast as you can. The mussels are strong enough to support your weight and octopuses are really hard to find!
- b. Stay on bare rock only and risk not seeing the octopus.
- c. Step lightly and quickly over the mussels and get back on bare rock as quick as you can.
- d. Stay where you are but throw rocks towards your classmates to scare the octopus away. If you can't see it, no one will!
- e. Other.