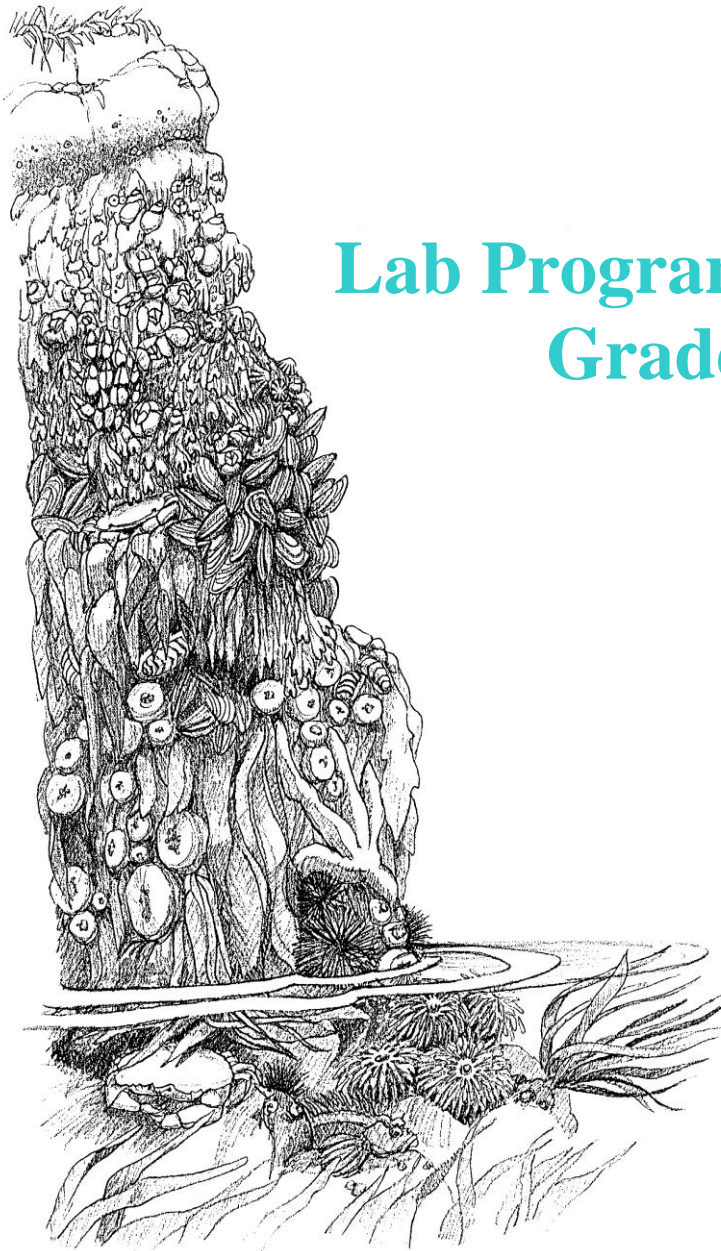


Ocean Commotion

Lab Program Curriculum
Grades 6-8



OREGON COAST
AQUARIUM
NEWPORT

Program Description

This 45-60 minute lab program focuses on the rough environment of the rocky intertidal zone and the specific adaptations of four animals that live there. During this program students and their chaperones will participate in a brief introduction to the rocky intertidal zone and the phylum groups cnidaria, arthropoda, echinodermata and mollusca. They will travel to four stations where they will explore the specific adaptations of an animal from each of those phyla. After this program students will understand how specific ocean animals are adapted to survive and some of the effects humans have on this fragile habitat. Participating in this program and using the enclosed activities will help your students meet ODE Science Content Standards and national Ocean Literacy Principles.

Chaperones will be asked to take an active role in the lab program, which is designed so that they read informational cards to the students in their group. It will also be the chaperone's responsibility to monitor the students' behavior during the lab program.

Before your visit:

- Find out how much your students already know about the ocean environment by trying the activity **Recipe for an Ocean**, included in this packet.
- Using the **enclosed descriptions of arthropods, cnidarians, echinoderms and molluscs**, review the characteristics of each phylum with your students. You may also want to review these characteristics with your chaperones.
- Have your students research an animal from one of the four phyla and write one or two pages on what their life would be like as this ocean organism. What hazards would they face? How would they adapt to overcome these hazards? How would they ensure the survival of their species?

During your visit:

- Provide your students and chaperones with copies of the **Oregon Coast Aquarium Self Guided Materials**. A master copy of the pages needed to create this booklet can be found on the Teacher Resources page at the Aquarium website, www.aquarium.org

After your visit:

- Introduce dichotomous keys to your students using the **Creature Classification** activity.
- To introduce discussion on environmental impact, try the enclosed **Dilemma Cards**.
- To create a visual representation of the harsh rocky intertidal environment, try the **Wave Wars** activity included in this packet.

Ocean Commotion addresses the following:

ODE Science Content Standards:

- 6.1** Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.
- 6.2** Interaction and Change: The related parts within a system interact and change.
 - 6.2L.2** Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.
- 7.2** Interaction and Change: The components and processes within a system interact.
 - 7.2L.2** Explain the processes by which plants and animals obtain energy and materials for growth and metabolism.
- 8.1** Structure and Function: Systems and their components function at various levels of complexity.
- 8.2** Interaction and Change: Systems interact with other systems.
 - 8.2L.1** Explain how species change through the process of natural selection. Describe evidence for evolution.

Ocean Literacy Principles:

Principle 5: The ocean supports a great diversity of life and ecosystems.

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

C: Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.

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

F: Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is “patchy”. Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

H: Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.

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 organism 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.

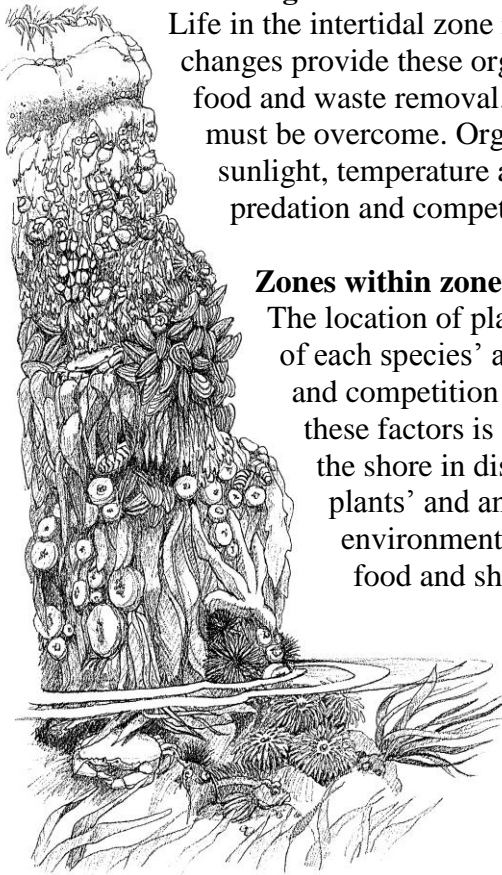
This rocky intertidal environment is a conglomeration of crannies, crevices and tide pools that provide an incredible variety of habitat. This diversity of habitat insures a diversity of species, both animal and plant.

It's a rough life

Life in the intertidal zone is by no means a quiet, peaceful existence. Tidal changes provide these organisms with 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

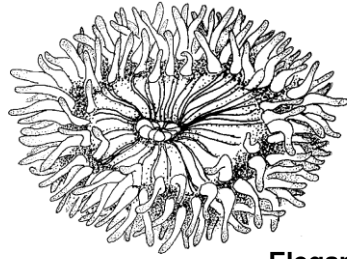
The location of plants and animals within the intertidal zone is a function of each species' ability to cope with exposure, wave action, predation and competition for space. Because the level of ability to cope with these factors is different for each species, they are distributed along the shore in 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, sea weeds and rocks to the place and position you found them.

Plants and animals of the rocky tidal zone

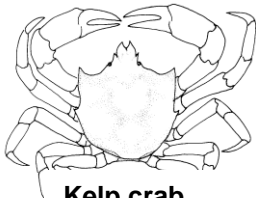
Although some fishes are found in this area, the most abundant animals living here are the invertebrates (animals without backbones). Some common invertebrates found here are crabs, sea stars, sea anemones, sea urchins, snails, chitons, mussels and barnacles.



Elegant anemone

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



Kelp crab

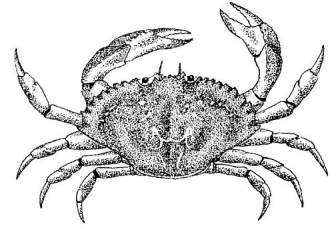
exoskeletons with seaweed to hide from predators. Kelp crabs are also often the color of the seaweed they live on. Snails and limpets have hard shells to protect their soft bodies and a very strong foot to hold on tight in the crashing waves. Sea anemones have soft, flexible bodies to move with the flow of water, and tentacles covered with stinging cells to capture and stun their prey.

Seaweeds are also abundant in the intertidal zone, where they can get plenty of sunlight and also provide a rich habitat of 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 types of kelp, 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.

Some Invertebrate Phyla Found at the Oregon Coast Aquarium

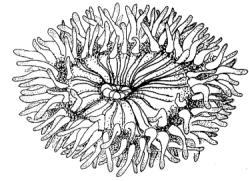
Arthropods (“jointed foot”)

Arthropods are segmented animals whose bodies are covered by an exoskeleton and whose appendages are jointed. There are over 920,000 known species of arthropod, both land-dwelling and aquatic. Some examples of animals belonging to this phylum are trilobites (extinct), crabs, shrimp, barnacles, ticks, spiders, and insects.



Cnidarians (“those that sting”)

Cnidarians are characterized by their radial symmetry, tentacles and stinging cells. They have no head, a simple nerve net, a hollow gut and a one-way digestive system. There are two cnidarians forms: the sessile polyp and the free-swimming medusa. Some cnidarians have both forms in their life cycle. Examples of animals belonging to this phylum are hydroids, jellyfish, sea anemones and corals.



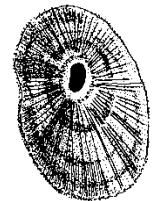
Echinoderms (“spiny skin”)

The 6,000 species of echinoderms are characterized by their radial symmetry as adults, an endoskeleton, a network of water-filled canals called a water vascular system, and tube feet. They have a nervous system but no head or brain. Some examples of animals belonging to this phylum are sea stars, sea urchins and sea cucumbers.



Molluscs (“soft body”)

Molluscs are characterized by a muscular foot, a head and viscera. Many have a sharp, rasplike tongue called a radula and most have a shell or a remnant of one. Snails, slugs, clams, mussels, chitons, squid and octopuses are included in the 100,000 species of mollusks.



Rocky Shore Invertebrates Vocabulary



- **alga** (*AL-guh*) [plural: **algae** (*AL-jee*)]: a member of certain phyla of the kingdom Protista (*proe-TIS-tuh*) (once considered plants). Most seaweeds are algae.
- **Aristotle's lantern**: the jaw structure, including five teeth, of a sea urchin
- **arthropod** (*ARR-thruh-pod*): a member of the phylum **Arthropoda** (*ar-THRAH-poe-dah*), a group of invertebrates with segmented bodies and jointed appendages. Crabs, barnacles, shrimps, insects and ticks are arthropods.
- **broadcast fertilization**: a method of reproduction in which eggs and sperm are released into the water, where fertilization and development occur
- **cilia** (*SILL-ee-ah*): hairlike appendages that can move together in a waving motion, used by some simple animals for locomotion and by more developed animals for moving fluids within the animal
- **cnidarian** (*nie-DAIR-ee-un*): a member of the phylum **Cnidaria** (*nie-DAIR-ee-ah*), a group of invertebrates with baglike bodies, stinging cells and typically with tentacles. Cnidarians include hydroids, sea anemones, jellyfishes and corals.
- **echinoderm** (*ee-KIE-nuh-derm*): a member of the phylum **Echinodermata** (*ee-KIE-nuh-der-MAH-tah*), a group of invertebrates with hard, spiny skeletons, radially symmetrical bodies and a water vascular system. Sea stars, sea urchins, sand dollars and sea cucumbers are echinoderms.
- **larva** (*LAR-vuh*) [plural: **larvae** (*LAR-vee*)]: an early developmental stage of an animal, which bears little or no resemblance to the adult
- **mollusc** (*MOLL-usk*): a member of the phylum Mollusca (*moh-LUSS-kah*), a group of invertebrates with soft bodies often enclosed completely or partially by a mantle and a shell. Snails, clams, octopuses, chitons, slugs and nudibranchs are molluscs.
- **nematocyst** (*neh-MA-tuh-SIST*): (means "thread bag") stinging structures that cnidarians use to capture food and for protection
- **operculum** (*oe-PER-cyoo-lum*): the hard pad on the foot of some gastropod snail which is used to seal the opening of the shell
- **pedicellaria** (*PEH-dih-seh-LAIR-ee-ah*): microscopic pincerlike structures around spines and gills of certain echinoderms for keeping their bodies free from debris; may also be used as defense against predators
- **plankton** (*PLANK-tun*): organisms suspended in water that drift with the currents and swim only weakly or not at all. Divided into phytoplankton (*FIE-toe-PLANK-tun*) (photosynthesizing members, mostly bacteria and algae) and zooplankton (*ZOE-PLANK-tun* or *ZOO-PLANK-tun*) (nonphotosynthesizing members, mostly animals and animal-like protists).
- **radula** (*RA-dyoo-lah*): the filelike band of teeth that snails, chitons and many other molluscs use to scrape, tear and bore
- **tentacle**: a slender, flexible appendage. The tentacles of cnidarians are filled with nematocysts.
- **test**: the shell, or covering, of animals such as sand dollars and sea urchins
- **tube feet**: soft, hollow, movable extensions of some echinoderms' water vascular system, which aid in locomotion, feeding and grasping

Recipe for an Ocean

Lesson at a glance:

This activity will inspire students to brainstorm the components that make up an ocean community and introduce them to the concepts of food chains and energy transfer.

ODE Science Content Standards:

- 6.1** Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.
- 6.2** Interaction and Change: The related parts within a system interact and change.
 - 6.2L.2** Explain how individual organisms and populations in an ecosystem interact and how changes in populations are related to resources.
- 7.2** Interaction and Change: The components and processes within a system interact.
 - 7.2L.2** Explain the processes by which plants and animals obtain energy and materials for growth and metabolism.
- 8.1** Structure and Function: Systems and their components function at various levels of complexity.
- 8.2** Interaction and Change: Systems interact with other systems.
 - 8.2L.1** Explain how species change through the process of natural selection. Describe evidence for evolution.

Ocean Literacy Principles:

Principle 5: The ocean supports a great diversity of life and ecosystems.

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

B: Most life in the ocean exists as microbes. Microbes are the most important primary producers in the ocean. Not only are they the most abundant life form in the ocean, they have extremely fast growth rates and life cycles.

C: Some major groups are found exclusively in the ocean. The diversity of major groups of organisms is much greater in the ocean than on land.

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

E: The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

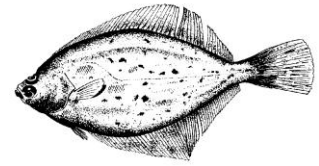
F: Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is “patchy”. Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

H: Tides, waves and predation cause vertical zonation patterns along the shore, influencing the distribution and diversity of organisms.

Principle 6: The ocean and humans are inextricably interconnected.

Materials:

- Large sheet of paper and crayons or markers for each group of students.



Activity:

1. Explain to students that they are going to create a “recipe” for an ocean. Begin by asking students to name some ingredients in (components of) the ocean. As they come up with ideas write or draw them on a large sheet of paper. This can be as creative or structured as the students would like to make it. Make sure that sunlight is included in their recipe.
2. Once a good list has been compiled, point out the producers. Draw lines from the producers to the animals that eat them and explain the term consumers. Continue until you’ve connected the entire list and formed a few complete food chains.
3. Ask students what decomposers are and where they should be drawn in. Ask them what the role of a decomposer is.
4. Explain that they have formed a cycle made up of producers, consumers and decomposers. Discuss the fact that this illustrates only a very small portion of the complex relationships among the organisms of the ocean.
5. Ask students what the role of humans might be in the cycles they have created.

Summary:

1. During your trip to the Aquarium, have your students find the components of the “recipe” they created and look carefully for those they may not have included.
2. Have them complete the ocean back at school.

Adapted from “Recipe for a Forest,” *Sharing Nature With Children*, J. Cornell, 1979.

Assessment:

Recipe for an Ocean Collaboration Rubric

Student Name: _____

Category	4	3	2	1	Score
Contributions	Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.	
Quality of Work	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/redone by others to ensure quality.	
Attitude	Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Often is publicly critical of the project or the work of other members of the group. Often has a negative attitude about the task(s).	
Focus on the task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on-task.	Rarely focuses on the task and what needs to be done. Lets others do the work.	
Monitors Group Effectiveness	Routinely monitors the effectiveness of the group, and makes suggestions to make it more effective.	Routinely monitors the effectiveness of the group and works to make the group more effective.	Occasionally monitors the effectiveness of the group and works to make the group more effective.	Rarely monitors the effectiveness of the group and does not work to make it more effective.	

Dilemmas

Lesson at a glance:

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

Common Curriculum Goals and Benchmarks:

SOCIAL SCIENCE ANALYSIS

- **Eighth Grade**

- **SS.08.SA.03** Examine a controversial event, issue, or problem from more than one perspective.
- **SS.08.SA.04** Examine the various characteristics, causes, and effects of an event, issue, or problem.
- **SS.08.SA.05** Consider two or more outcomes, responses, or solutions; identify their strengths and weaknesses; then conclude and justify which is the best.

Ocean Literacy: Essential Principles and Fundamental Concepts

6. THE OCEAN AND HUMANS ARE INEXTRICABLY INTERCONNECTED.

- 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:

- Dilemma cards (enough for each group)

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.

It is not the intent of this activity to prescribe right and wrong answers for the students.

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 give the choices of answers to the rest of their group.
3. Students in the group should decide on their own what their response would be. Then have each group discuss their choices among themselves. Students should be able to defend their reasoning.

Summary:

Discuss each dilemma as a class. 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 an understanding of all positions.

Extension:

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

Adapted from "Ethi-reasoning," Project Aquatic, Boulder, Colorado, 1992.

Dilemmas

<p>1. You have just cleaned your basement. On a dusty back shelf you discovered 10 cans of old paint and some very old pesticides and weed killers that you can't use. What will you do with them?</p>	<p>4. You were fishing at a secluded lake and caught seven fish this morning. Now, its afternoon and the fishing has been great! You have caught five fish in one hour, all of which are on your string in the water and are bigger than this morning's fish. The law allows you to possess 10 fish per day. What should you do?</p>
<p>2. You are walking on the shore with a friend who is visiting you from the Midwest. Your friend sees a purple sea star she thinks is very beautiful. She tells you she wants to go into the tide pool and get it to take it home. What do you do?</p>	<p>5. You are on a field trip to the Newport bay front. Although you know it's not a good idea to feed the wildlife, some of your friends are tossing pieces of their tunafish sandwiches to the sea lions. What should you do?</p>
<p>3. You are an expert salmon angler. You always know where the BIG ones are. You're sanding on the side of a stream where you know the salmon run. On the far side of the stream you see a pool you just know has the BIG one in it, but to get there you must cross the stream. You know this is probably an area with salmon redds (nests), but no one from the Department of Fish and Wildlife is around and you're expected to come home with fish for dinner. What do you do?</p>	<p>6. You're on a charter boat with your family during your summer vacation. Your grandfather, a grumpy, stubborn man, is a heavy smoke and keeps throwing his plastic cigar butts over the side. What should you do?</p>

Choices

<p>4.</p> <ul style="list-style-type: none"> a. Continue to fish and keep all the fish. b. Let the smallest fish you caught this afternoon go free and keep the big ones to stay within your limit. c. Quit fishing and go for a hike. d. Continue to fish but release them. e. Other 	<p>1.</p> <ul style="list-style-type: none"> a. You know it's illegal, but you simply hide them in your garbage can with your other household waste and have taken to the county landfill. b. Leave them in your basement. c. Call the county to find out where to dispose of them safely. d. other
<p>5.</p> <ul style="list-style-type: none"> a. Tell them that feeding the sea lions can harm the animals and ask them to stop. b. Report their behavior to an authority on the dock. c. Ask the teacher to ask them to stop. d. Ignore them. e. Other 	<p>2.</p> <ul style="list-style-type: none"> a. You notice that there are many sea stars and you think it won't hurt anything to take just one. b. Offer to pull it off the rock and suggest you play Frisbee with it. c. Explain that this animal won't be able to survive if she takes it home and suggest that she watch it here and then leave it in its habitat. d. Yell at her and ask her how she would feel if someone picked her up and threw her out in the ocean e. Other.
<p>6.</p> <ul style="list-style-type: none"> a. Yell at him, call him an idiot and ask him if he hasn't heard of the MARPOL Protocol, the law prohibiting the dumping of all plastic wastes from ships at sea. b. Ask the captain for a can, give it to your grandfather and politely ask him to use it for his cigarette butts. c. Do nothing. d. Tell your parents to tell your grandfather to quit smoking. e. Other 	<p>3.</p> <ul style="list-style-type: none"> a. Go to the nearest house and ask to borrow their boat, knowing you'll be in the doghouse if you don't come home with fresh fish. b. Put on your best lure, cast as close to the pool as possible and hope for the best. c. Carefully walk through stream. d. Go to the fish market for fish for dinner. e. Other

Assessment:

Dilemmas Rubric

Student Name: _____

CATEGORY	4	3	2	1	Score
Respect for other classmates	All statements, body language, and responses were respectful and were in appropriate language.	Statements and responses were respectful and used appropriate language, but once or twice body language was not.	Most statements and responses were respectful and in appropriate language, but there was one sarcastic remark.	Statements, responses and/or body language were consistently not respectful.	
Information	All information presented in the discussion was clear, accurate and thorough.	Most information presented in the discussion was clear, accurate and thorough.	Most information presented in the discussion was clear and accurate, but was not usually thorough.	Information had several inaccuracies OR was usually not clear.	
Use of Facts/Statistics	Position was well supported with several relevant facts, statistics and/or examples.	Position was adequately supported with relevant facts, statistics and/or examples.	Position was supported with facts, statistics and/or examples, but the relevance of some was questionable.	Position was not supported.	
Presentation Style	Student consistently used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Student usually used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Student sometimes used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Student had a presentation style that did not keep the attention of the audience.	

Wave Wars

Lesson at a glance:

Through this activity, students will gain a clear understanding of the tremendous force that waves of the Oregon shores put on the plants and animals that live here. Groups of students will work cooperatively to create an organism that will withstand the force of a simulated wave.

ODE Science Content Standards:

- 6.4** Engineering Design: Engineering design is a process of identifying needs, defining problems, developing solutions, and evaluating proposed solutions.
6.4D.2 Design, construct, and test a possible solution to a defined problem using appropriate tools and materials. Evaluate proposed engineering design solutions to the defined problem.
- 7.2** Interaction and Change: The components and processes within a system interact.
7.2P.1 Identify and describe types of motion and forces and relate forces qualitatively to the laws of motion and gravitation.
- 7.4** Engineering Design: Engineering design is a process of identifying needs, defining problems, identifying constraints, developing solutions, and evaluating proposed solutions.
7.4D.2 Design, construct, and test a possible solution using appropriate tools and materials. Evaluate the proposed solutions to identify how design constraints are addressed.
- 8.2** Interaction and Change: Systems interact with other systems.
8.2P.2 Explain how energy is transferred, transformed, and conserved.
8.2L.1 Explain how species change through the process of natural selection. Describe evidence for evolution.
- 8.4** Engineering Design: Engineering design is a process of identifying needs, defining problems, identifying design criteria and constraints, developing solutions, and evaluating proposed solutions.
8.4D.2 Design, construct, and test a proposed engineering design solution and collect relevant data. Evaluate a proposed design solution in terms of design and performance criteria, constraints, priorities, and trade-offs. Identify possible design improvements.

Ocean Literacy: Essential Principles and Fundamental Concepts

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

Materials

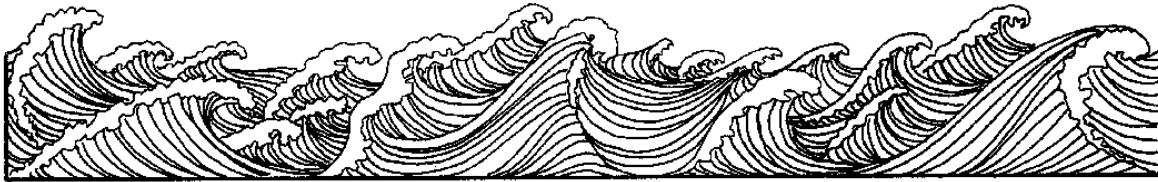
- Cloth bag or pillow case lined with a plastic bag and filled with seven pounds of birdseed or rice
- Masking tape
- Several sheets of card stock (manila folders cut in half work well)
- Scissors
- Other materials as desired: toothpicks, tissue, cardboard, markers, paperclips, suction cups etc.

Activity:

Begin by asking the class to brainstorm reasons why life in a tide pool might be difficult. Discuss the force of waves along the shores of the Oregon coast. Why are waves hazardous? Ask the students to imagine themselves as animals living on the rocky shore. The tide is coming in. How are they going to survive? How will they keep from being washed away? How would they change their body shape to better suit this environment?

Explain to the students that the animals of the rocky intertidal zone have developed ways to stay secured to the rocks and also to avoid being crushed by objects that come crashing in with the waves.

1. Divide the class into groups of three or four.
2. Give each group one 8 ½ "x 11" sheet of card stock, 1 ½ inches of tape, and scissors. (other materials if desired)
3. Explain that the challenge of each group is to build a shape that will withstand the force of a high-energy wave. The "wave" is the seven-pound bag of birdseed or rice swung down from seven feet. Drop the bag once to give students an idea of the force of this wave. Be sure each group understands that their shape does not have to look like a real plant or animal.
4. Give students about 20 minutes to create their "organism."



5. Once each group has made an organism, ask them to record the following information:
 - A sketch and description of the shape.
 - A prediction as to whether or not they think their shape will survive and why?
6. Test the organisms by dropping the bag directly on each one from a height of seven feet. Alternate wave operators. Always have a student whose organism is not being tested be the operator.
7. When all the organisms have been tested, ask each group to record:
 - The results of the wave. What happened and why?
 - A sketch and description of their new shape. Were their predictions correct?

Summary:

Discuss the impact the wave had on each organism. Which ones survived? Which ones were crushed?

Using pictures, compare the newly created organisms to some common tidepool animals perhaps a few your students saw at the Aquarium. Explain how plants and animals have adapted in shape, size texture and behavior to survive in this harsh environment.

Many animals living in the intertidal zone have body shapes that can resist the force of constant wave impact. For example, a sea star's body is flat and spread out over a wide area, and many species of barnacles create a hard volcano-shaped casing to protect their vulnerable bodies.

Many tidepool organisms have tough skin, spines or heavy shells to protect them from powerful waves.

Some tidepool animals have adaptations to keep them from being swept away by the waves. For example, sea stars have strong tube feet and mussels have tough, plasticlike threads to secure themselves to rocks.

Animals that move, such as sea stars, snails, limpets and chitons, can do so while remaining firmly attached to a surface with strong muscular or water vascular suction.

Flexibility is another helpful adaptation for animals and plants in the rocky intertidal zone. For example, leaf barnacles have flexible stalks that are sealed snugly in mussel beds, and seaweeds are also flexible enough to bounce back as the waves crash over them.

Animals that are not so well adapted to this environment take shelter from the force of the waves under the rocks or seaweed.

Extension:

Ask student which environment is calmer: the sandy beach or the rocky shore. Do they think the animals that live in these two environments are the same or different? What would some of the differences be? Which habitat do they think will have more animals? Why?

Compare the impact of waves on a protected coastline to that of a highly exposed coastline. This can be done using a one- to three-pound bag of birdseed to represent the exposed coastline. Try testing the organisms first on a protected coast and then on an exposed coast.

Use this lesson to discuss natural selection of animals, different forms of energy and forces, and the conservation of that energy and force.

Adapted from "The Wave." New England Coastlines. Boston: New England Aquarium. 1991.

Assessment :

Wave Wars

Student Name: _____

CATEGORY	4	3	2	1	Score
Modification/ Testing	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.	
Function	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well, but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.	
Scientific Knowledge	Explanations by all group members indicate a clear and accurate understanding of scientific principles underlying the construction and modifications.	Explanations by all group members indicate a relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by most group members indicate relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by several members of the group do not illustrate much understanding of scientific principles underlying the construction and modifications.	
Construction - Materials	Appropriate materials were selected and creatively modified in ways that made them even better.	Appropriate materials were selected and there was an attempt at creative modification to make them even better.	Appropriate materials were selected.	Inappropriate materials were selected and contributed to a product that performed poorly.	
Journal/Log - Content	Journal provides a complete record of planning, construction, testing, modifications, reasons for modifications, and some reflection about the strategies used and the results.	Journal provides a complete record of planning, construction, testing, modifications, and reasons for modifications.	Journal provides quite a bit of detail about planning, construction, testing, modifications, and reasons for modifications.	Journal provides very little detail about several aspects of the planning, construction, and testing process.	

Creature Classification

Lesson at a glance:

In this lesson, students will gain an understanding of how organisms are classified through the use of a dichotomous key.

ODE Science Content Standards:

- 6.1 Structure and Function: Living and non-living systems are organized groups of related parts that function together and have characteristics and properties.
- 7.1 Structure and Function: Living and non-living systems are composed of components which affect the characteristics and properties of the system.
- 8.1 Structure and Function: Systems and their components function at various levels of complexity.
 - 8.1L.1 Explain how genetics and anatomical characteristics are used to classify organisms and infer evolutionary relationships.

Ocean Literacy: Essential Principles and Fundamental Concepts

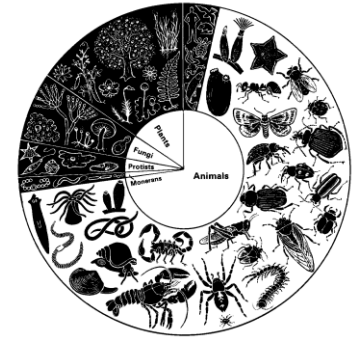
5. THE OCEAN SUPPORTS A GREAT DIVERSITY OF LIFE AND ECOSYSTEMS.

Materials:

- Animal images provided in this packet
- Resources including the internet for researching animal characteristics

Background information:

In order to identify the scientific group that a certain organism belongs to, scientists use a shorthand guide based on external and internal characteristics. This guide is called a dichotomous key. Dichotomous means “two forks.” Each step to keying out an organism is a simple “yes” or “no” answer to successive questions in a key.



Activity:

1. Discuss dichotomous keys with students. Explain to students that animals may have several similarities even though they are classified in very different categories, and that there is not necessarily one right answer.
2. To illustrate this concept, use the attached example of a key for identifying the orders of mammals native to the Oregon coast.
3. Next, hand out copies of the attached animal images.
4. As a class, brainstorm common characteristics of the animals to be classified.
5. Divide students into groups and assign each group two of the animals to research. Their task is to come up with a list of external and internal characteristics. Suggest that students look at many features including body covering, appendages, means of locomotion and mode of reproduction.
6. Have students regroup when research activity is complete. As a class, have students share the characteristics they came up with for their two animals.

7. Students will be able to create a dichotomous key for all of the animals by comparing body parts, habitats and behaviors of all eight animals they are classifying. Remind students to begin with general questions and become progressively more specific.

Summary:

- Have each group of students compare its key to those produced by other groups. What characteristics did the students focus on to help them classify the organisms? Did everyone create the same key? How are the keys different?
- Discuss how an organism familiar to students might be identified using a key.

Oregon Coast Mammals Key

1a Forelimbs developed into leathery wings CHIROPTERA (bats)

1b Forelimbs not developed into wings (*go to 2*)

2a Front limbs developed into paddlelike flippers; hind limbs absent; body ending in expanded horizontal fluke; blow hole (one or two nostrils); hairless or nearly hairless body CETACEA (whales, dolphins and porpoises)

2b Front and hind limbs present; body not ending in horizontal, expanded fluke; nostrils not on top of head; body covered with hair (*go to 3*)

3a Front and hind limbs developed into flippers for swimming PINNIPEDIA (true seals and eared seals)

3b Front and hind limbs not developed into flippers for swimming (*go to 4*)

4a Toes ending in hooves; four toes on each foot ARTIODACTYLA (even-toed hoofed animals)

4b Toes usually ending in claws, not hooves (*go to 5*)

5a Ears prominent, round, naked, thin, leathery, black; tail long, tapering, scaly, naked, prehensile; inside toes of hind feet large, lack claws, are more or less opposable to other toes MARSUPIALIA (pouched mammals)

5b Ears, if prominent, covered with hair; if naked, concealed in body hair. Tail usually well haired; if naked, not prehensile. Claws on all toes (*go to 6*)

6a Snout highly flexible, protruding beyond mouth; small eyes, sometimes hidden by hair INSECTIVORA (insect eaters)

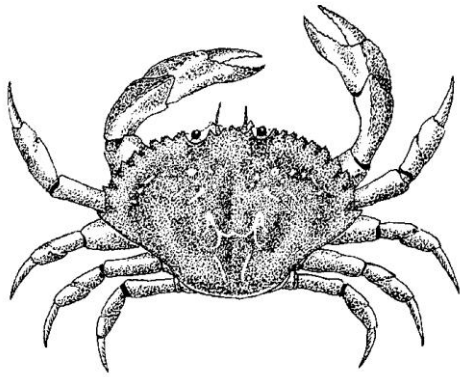
6b Snout normal, neither highly flexible nor protruding beyond mouth. Eyes usually large; if small, readily visible (*go to 7*)

7a Fangs (canines), adapted for seizing prey, projecting far beyond other teeth CARNIVORA (flesh eaters)

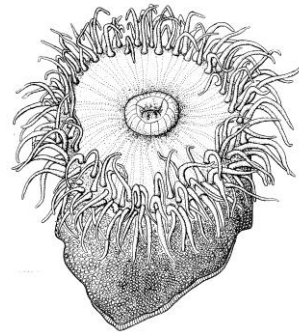
7b Fangs absent; front (incisor) teeth well developed and separated from the molars by a wide gap (*go to 8*)

8a Ears proportionately long and narrow. Hind feet long, narrow and soles covered with dense hair; movement is characteristic hop of a rabbit. LAGOMORPHA (hares, rabbits and allies)

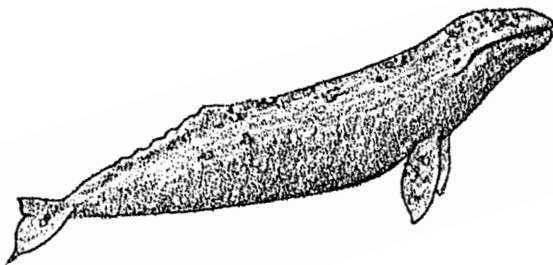
8b Ears proportionately small. Hind feet variously shaped but soles naked or nearly so; varied movement but not characteristic hop of a rabbit. Upper front teeth usually orange or yellow; if whitish, deep, longitudinal grooves absent RODENTIA (rodents)



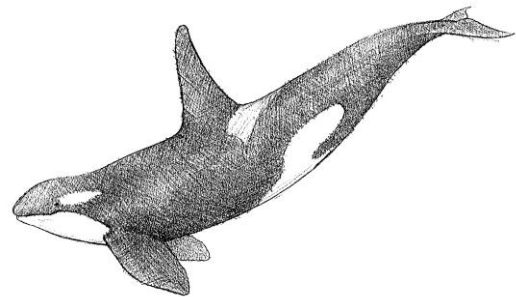
Dungeness crab



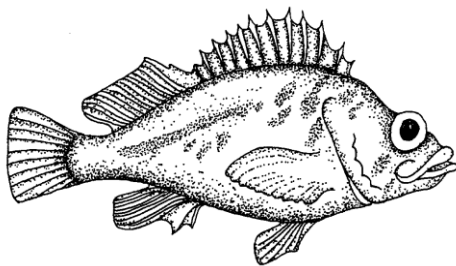
Giant green sea anemone



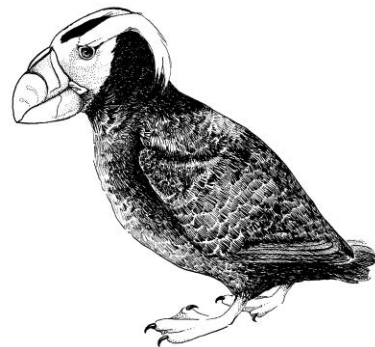
Gray whale



Orca or killer whale



Rockfish



Puffin

Assessment:

Collaborative Work Skills: Creature Classification

Student Name: _____

CATEGORY	4	3	2	1	Score
Contributions	Routinely provides useful ideas when participating in the group and in classroom discussion. A definite leader who contributes a lot of effort.	Usually provides useful ideas when participating in the group and in classroom discussion. A strong group member who tries hard!	Sometimes provides useful ideas when participating in the group and in classroom discussion. A satisfactory group member who does what is required.	Rarely provides useful ideas when participating in the group and in classroom discussion. May refuse to participate.	
Quality of Work	Provides work of the highest quality.	Provides high quality work.	Provides work that occasionally needs to be checked/redone by other group members to ensure quality.	Provides work that usually needs to be checked/redone by others to ensure quality.	
Problem-solving	Actively looks for and suggests solutions to problems.	Refines solutions suggested by others.	Does not suggest or refine solutions, but is willing to try out solutions suggested by others.	Does not try to solve problems or help others solve problems. Lets others do the work.	
Attitude	Never is publicly critical of the project or the work of others. Always has a positive attitude about the task(s).	Rarely is publicly critical of the project or the work of others. Often has a positive attitude about the task(s).	Occasionally is publicly critical of the project or the work of other members of the group. Usually has a positive attitude about the task(s).	Often is publicly critical of the project or the work of other members of the group. Often has a negative attitude about the task(s).	
Focus on the task	Consistently stays focused on the task and what needs to be done. Very self-directed.	Focuses on the task and what needs to be done most of the time. Other group members can count on this person.	Focuses on the task and what needs to be done some of the time. Other group members must sometimes nag, prod, and remind to keep this person on-task.	Rarely focuses on the task and what needs to be done. Lets others do the work.	

Monitors Group Effectiveness	Routinely monitors the effectiveness of the group, and makes suggestions to make it more effective.	Routinely monitors the effectiveness of the group and works to make the group more effective.	Occasionally monitors the effectiveness of the group and works to make the group more effective.	Rarely monitors the effectiveness of the group and does not work to make it more effective.	
Working with Others	Almost always listens to, shares with, and supports the efforts of others. Tries to keep people working well together.	Usually listens to, shares, with, and supports the efforts of others. Does not cause "waves" in the group.	Often listens to, shares with, and supports the efforts of others, but sometimes is not a good team member.	Rarely listens to, shares with, and supports the efforts of others. Often is not a good team player.	