The following lessons are grouped into three categories: pre-trip, during the trip, and post-trip. If you do pre-trip lessons, plan how to refer to them while on the trip. If you plan to do any of the post-trip lessons, be aware of ways to prepare the students while on the trip by making observations or asking questions.

Each category is further divided into Hands-On Activities and Other Activities of various types.

California State Content Standards that can easily be addressed through the lessons are referenced by subject and number. See pages 143–146 for abbreviated summaries of the standards.

Some of the hands-on activities are intended to be **discovery** activities (experiments) in which the students don't know the answers ahead of time. The teacher should try to facilitate the students' discoveries rather than telling them what to expect. Whenever possible, **be a guide on the side**!

Also . . . it is **HIGHLY** recommended that the teacher:

- Try out all experiments **before** having students do them.
- Enlist the help of parent volunteers before, during, and after experiments.
- Feel free to adapt, expand, or alter experiments to suit your needs, student needs, and resources.

Hands-on or "lab" type activities are presented in a detailed lesson plan format.

A few "other" activities are given as examples, but the resources in the curriculum of the resources section (p. 158) give **many** additional worthwhile activities.

Many of the lessons begin before the field trip and continue with activities to be done while at the coast. Others that are listed as pre-trip can also be done after the trip.

For some lessons, I have provided a reference to a book in which there is a similar lesson. Variations on many of these lessons can be found in several books.

Pre-Trip Lessons and Activities

Before bringing students to study the intertidal zone, the teacher should visit the area and discuss the field trip with the ranger or interpretive specialist. It would be best to join a tide pool walk at a low tide. The interpreter will be able to provide information about unique opportunities at the particular field trip site. He or she will also be able to tell you about any special safety or conservation concerns. Discuss planned activities with the interpreter.

It is recommended that each student have a plastic magnifier on a string around his or her neck when at the tide pools. Have the students get used to using these magnifiers **before** going on the trip.

The teacher should also bring some plastic bowls or Petri dishes, a large plastic pan or bucket, "bug boxes" or "2-way magnifiers," towels, and, possibly, binoculars.

Pre-trip hands-on activities begin on page 76.

Underwater Viewers

Students can make underwater viewers for studying intertidal life. These are most useful if the students will sit beside a tide pool for several minutes and use them to look beneath the surface.

Be sure to have someone watching for waves!

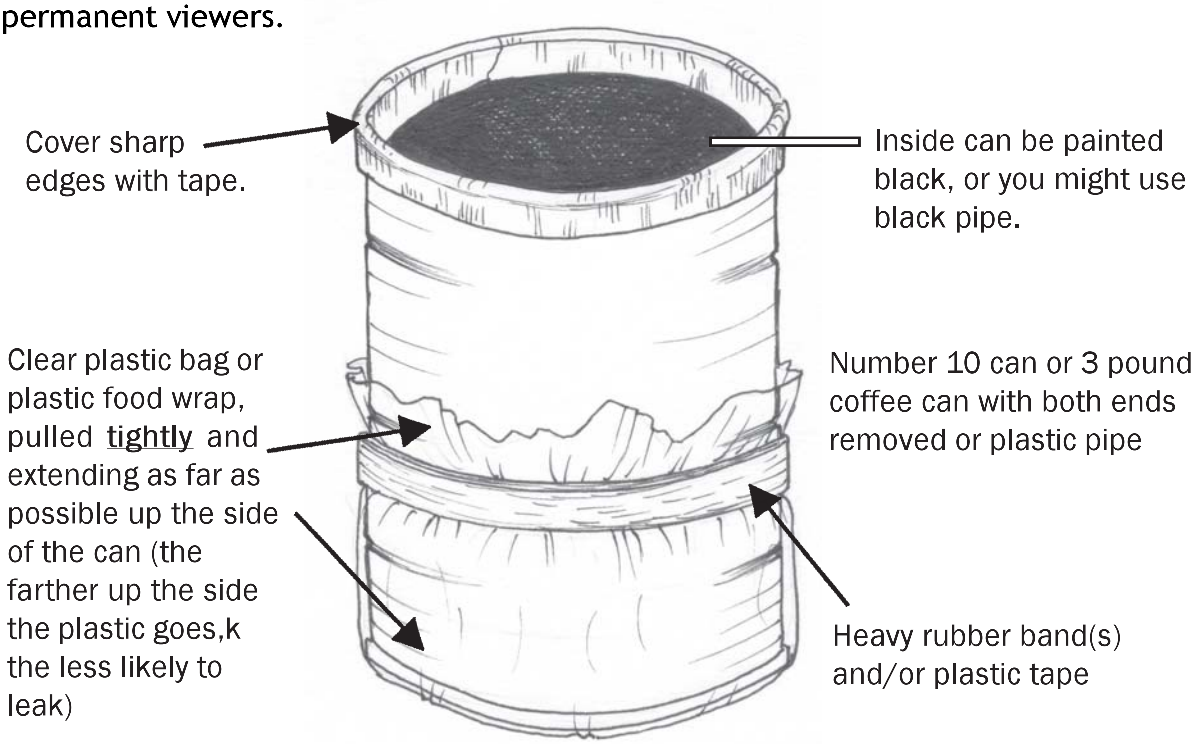
Viewers can be made from #10 cans with both ends removed (from the cafeteria or a restaurant), 3 pound coffee cans, juice cans, or even 1'-3' lengths of plastic pipe.

There will be less glare if the inside is painted black.

Cover the lower end with a clear plastic bag or plastic food wrap, **extending it up as far as possible**, pulled tight and attached with heavy rubber bands or plastic tape.

Cover any sharp edges with duct tape.

A building or plumbing supply store or building contractor might donate plastic pipe. A plastic supply company might even donate clear plastic and glue to make permanent viewers.



Note: Clear plastic storage boxes or plastic jars with clear (smooth) bottoms can also be used.

NEVER use glass jars at the beach because of the danger of breakage.

Reference

Brown, *Exploring Tidepools*, p. 12

The Name Game

Activity Summary

Students give descriptive names to organisms they find at the coast.

Introduction

The first thing people usually want to know about an organism is its name. Before telling students the name of an organism, it is sometimes a good idea to let them name it. If they are encouraged to give it a descriptive name, they have to examine the organism more closely as they look for distinctive characteristics.

Grouping

Tide pool exploration groups

Time

Varies

Anticipated Outcomes

Students will examine organisms closely.
Students will use descriptive words to make up names for organisms.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, Investigation 5.a, 5.b
Grade 4 - Reading 1.3, 1.4; Investigation 6.a
Grade 5 - Investigation 6.a

Materials

❒ Magnifiers

Teacher Preparation

❒ Consider doing some word root study at school before the field trip.

Procedure

Before the trip:

1. Study word roots with the students and discuss how they can be used to name organisms. Examples of descriptive names of tide pool animals include lined chiton as compared to mossy chiton, giant green anemone, lined shore crab, black abalone, and black turban snail.

During the trip:

1. As students find organisms, discuss how they got their names. (See examples above.)
2. Sometimes when a student finds an organism, rather than telling the name, have the group examine the organism and come to consensus about an appropriate descriptive name.

Food Chains

Activity Summary

Students learn about tide pool organisms and how they relate in food chains. (This activity should be followed by the following Food Web activity.)

Introduction

Food chains represent a simplified view of the passage of energy and materials through an ecosystem. They are useful because they are much less complex than the more realistic food webs. See pages 23-24 for a review of food webs and food chains.

This activity provides a good opportunity to reinforce the idea that all living things depend on the non-living environment.

You might consider putting together sets of food chain cards for various habitats such as grasslands, fresh water, redwood forests and deserts. (See Roa, *The Environmental Science Activities Kit*, pages 151-162.)

Grouping

4-6 students per food chain

Time

Research: Varies (15-30 minutes)
Doing the activity and discussion: 15-30 minutes

Anticipated Outcomes

Students will understand that all organisms depend on the physical environment.
Students will understand the concept of food chains.
Students will know about the niches and foods of various organisms.
Students will improve their research skills.

Standard(s)

Grade 3 - Life Science 3.a, 3.b
Grade 4 - Life Science 2.a, 2.b, 2.c, 3.a, 3.b, 3.c
Grade 5 - Listening and Speaking 1.1
Grade 6 - Ecology 5.a-5.e

Food Chains (continued)

Materials

- ❒ Reference books or other resources that tell about organisms' feeding/food needs
- ❒ White paper or tag board, approx 8" x 8" (1 per student)
- ❒ Colored pencils, pens, or crayons
- ❒ Optional: pictures of organisms from magazines such as National Geographic (often available at garage sales, libraries, or flea markets) or from calendars (often available from bookstores for free after the Christmas season—or ask parents for last year's nature calendars).

Teacher Preparation

- ❒ Consider having a parent volunteer mount and laminate pictures of various organisms on the paper or tag board heavy paper; or,
- ❒ Obtain pictures of various organisms. (See the book listed in the Reference section on next page.)
- ❒ Either prepare a large drawing or find a picture to represent the physical environment, including sunlight, water, and minerals. (This might be a picture of the sun over a rocky coast.)
- ❒ Group the food chains into groups of 4-6 organisms. Have some optional organisms in case some students are absent. Some examples of groups are:

Abiotic Factors	Producer	Herbivore (first degree consumer)	Carnivore (second degree consumer)	Carnivore or Omnivore	Next Step
sun, water, and minerals (or sea water, which contains minerals)	diatoms	zooplankton	mussel	sea star	bacteria
	diatoms	zooplankton	small fish	salmon	fisherman
	algae	turban snail	crab	sea star	sea gull
	algae	sea urchin	crab	octopus	shark
	algae	abalone	sea otter	killer whale	bacteria
	surf grass	crab	sea anemone	small fish	bacteria
Other types of organisms to consider for cards: dead fish, other people, shark, pelican					

Procedure

1. Assign one organism to each student.
2. The student does research to find out what their organism eats and what eats it.
3. Unless a picture is provided on a card, the student draws a picture of the organism.
4. The student then gets together with his or her food chain group and decides the order of the food chain, starting with the physical environment.
5. Students line up in food chain order.
6. For each chain, the teacher holds up the large physical environment card and reminds the students about the importance of sunlight, minerals, and water. This is the start of the food chain.

Food Chains (continued)

7. When all food chains are formed, students explain to the other groups why they are in this order. They might hold up their picture and say something like “I’m a turban snail. I eat algae from the rocks, and sea gulls feed on me.”
8. Tell the students that when they see an organism at the tide pools, they should be ready to tell what it eats and what eats it.
9. Remind the students that most organisms eat many different things and many things eat each organism. See the next activity “Food Webs.”

<u>Discussion</u>

1. See steps 6-9 above. Discuss what would happen if something happened to the physical environment (water pollution, sediments blocking sunlight), or if something happened to an animal’s food source.

<u>Assessment</u>

- Can students tell about “their” organism’s food and predators?

<u>Reference</u>

Roa, *The Environmental Science Activities Kit*, p. 151-162

Food Webs

Activity Summary

After learning about food chains, students form a model of a food web, demonstrating the interconnectedness of organisms.

Introduction

While a food chain makes it easy to see how some organisms are related to each other in their habitat, it is an oversimplification. In reality, most organisms eat and are eaten by several types of organisms. These interconnecting relationships can be viewed as a food web. See pages 23-24 for a discussion of food chains and food webs.

Grouping

About 10-12 students will form the food web. The rest of the class can observe.

Time

10-30 minutes, including discussion

Anticipated Outcomes

Students will increase their understanding of food webs.
Students will understand how something affecting one part of a food web or environment can affect other parts.

Standard(s)

Grade 3 - S.S. 3.1.2, 3.2.2, 3.4.2; Life Science 3.c, 3.d
Grade 4 - S.S. 4.2.1, Life Science 2.a, 2.b, 2.c, 3.b, 3.c, Investigation 6.a
Grade 5 - Life Sciences 2.a, Investigation 6.a
Grade 6 - S.S. 6.1.2; Ecology 5.a-5.e; Investigation 7.d, 7.g, 7.h

Materials

- ❐ Drawings or pictures of organisms and abiotic environmental factors, approximately 8" x 8" in size, mounted on tag board, with strings for hanging around the students' necks.
- ❐ Have pictures to represent, for example:

Sunlight	Water	Minerals	Decomposers (bacteria)
Producer (algae)	Herbivore (abalone)	Herbivore (turban snail)	Carnivore (sea otter)
Carnivore (fish)	Scavenger (sea gull)	Scavenger (crab)	Carnivore (mussel)

**Also have one card to represent people: On one side label the person something like "Wasteful Wally" and the other side "Wonderful Wally."

- ❐ String or yarn (approx. 50')

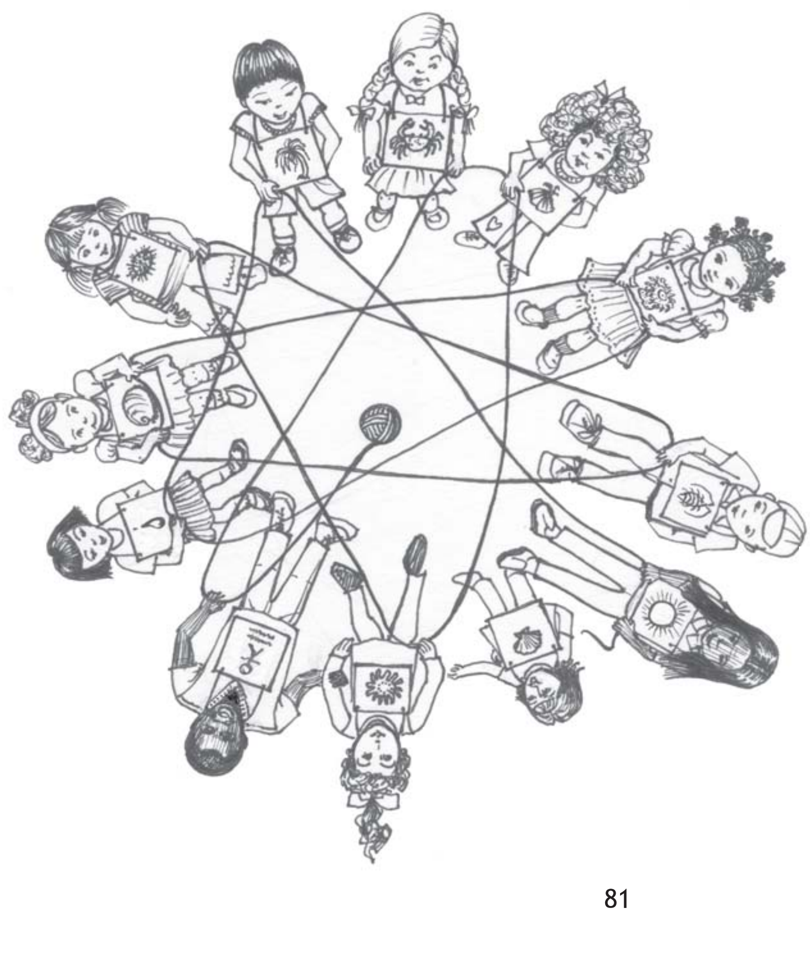
Food Webs (continued)

Teacher Preparation

- ❒ Obtain pictures or drawings of the above. Pictures or drawings used in the Food Chains activity might be used.
- ❒ Mount the pictures on tag board. Attach string so that each picture can be worn around a student's neck.

Procedure

1. Select 10-12 students to represent the parts of the environment listed under Materials above. Have the students form a circle, facing inward.
2. Give the students their role cards and have them hang them around their necks. The human card should have "Wasteful Wally" facing outward. Be sure to issue the role cards in such a way that a web will form. (Have the sun across the circle from the algae.)
3. Have the "sun" student hold the end of the string. As you connect the sun to the algae by bringing the string to the algae student, ask one of the class members to explain how the sun affects the algae. The "algae" student grasps the string. Ask another to discuss how the algae is related to minerals as you bring the string to the student with the mineral card. Ask another student to tell how minerals affect herbivores (herbivores need algae, which need minerals) as you bring the string to the herbivore student. Continue in this way until all organisms are in the web, connecting to the "human' and then finally back to the sun. (The human is connected to the sun because humans need food that needs the sun to grow.)



Food Webs (continued)

4. Now have all of the students hold their string firmly in one hand and pull the string taut. A web should be formed among the "organisms." Point out that everything is connected (or "hitched to everything else," as John Muir said).
5. Tell the students that you are going to tap a student and tell something that happened to that part of the environment.
6. Instruct the students to hold their string firmly, and to tug <u>gently</u> when they feel a tug.
7. Walk around the circle and tap a student on the shoulder and tell about something that happened to the organism. This is the initial event. The tapped student is to give a tug on the string. (The abalone was eaten by an otter, or the crab was accidentally killed by a student on a field trip, or the water was polluted by a factory, etc.)
8. This should start a chain reaction, and every part of the environment should soon have been affected by the initial event. Have each affected student (or someone in the class) tell how they were affected.
9. Do this several times, with different initial events, pointing out that if one part of the environment is affected, all parts are affected.

<u>Discussion</u>

1. It is easy to see how the environment is harmed by many things. It is very important that the students see that people can also <u>help</u> the environment. Discuss how Wasteful Wally can also choose to be Wonderful Wally. Ask for examples of how Wally could help improve and protect the environment.
2. Compare organisms' roles or niches to the various niches that people with different jobs fill in the human community. Discuss how people with different jobs depend upon each other.

<u>Assessment</u>

- Are the students able to tell how organisms are interconnected?
- Are the students able to tell how organisms depend on the abiotic factors?
- Can the students tell ways that Wasteful Wally can be Wonderful Wally?

<u>References</u>

Roa: *Environmental Science Activity Kit*, p.152-162.
Snively: *Once Upon a Seashore*, p. 138-140.

Slow Motion Ocean (Making Waves)

Activity Summary

Students create waves by blowing through straws on a pan of water. They then use a model to observe the way that approaching shallow water causes waves to break.

Introduction

Most ocean waves are caused by wind blowing across the surface of the ocean. The stronger the wind and the longer the time it blows across the water, the larger the waves.

As a wave approaches a beach, it encounters shallow water. The lower part of the wave, being in contact with the land under the sea, is more influenced by friction with the bottom and slows down more than the top. Thus, the top of the wave "outruns" the bottom, which is what causes waves to "break."

If a wave encounters a reef or shallow bottom far from the shore, much of the energy is dissipated by the offshore breakers. When the water remains deep until close to shore, the waves tend to hit the shore with much more force.

Students should be reminded that a wave isn't a mass of water moving from one place to another. If it were, the place from which the waves came would soon run out of water. Rather, a wave is energy moving through the water, which displaces the water slightly.

Grouping

3-5 students per group

Time

Approximately 30 minutes, if the wave bottles are already made; more if the students are making the bottles

Anticipated Outcomes

Students will understand that wind is the cause of most waves.
Students will understand why waves "break."

Standard(s)

Grade 3 - Writing 2.2; Physical Science 1.d, Investigation 5.a, 5.b
Grade 4 - Earth Science 5.c, Investigation 6.a-d
Grade 5 - Earth Sciences 3.c, Investigation 6.b-6.i
Grade 6 - Earth Science 2.c, Physical Science 3.a, Investigation 7.a-h

Slow Motion Ocean (continued)

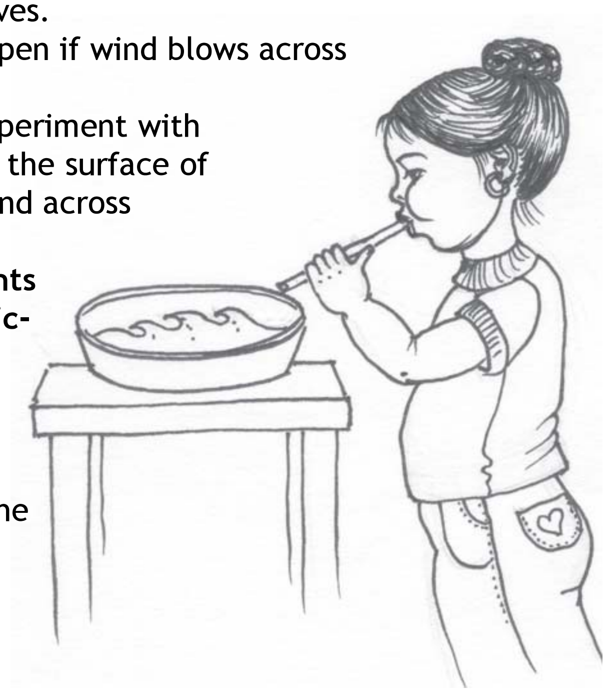
Materials

For each group:
- ❒ 1 shallow pan (pie tin, baking pan, paint tray, or? ... maybe with sand in it?)
- ❒ 1 or 2 straws
- ❒ 1 clear large ketchup or other bottle with a long tapered neck and cap (see diagram)
- ❒ Corn syrup and vegetable oil (the amount will depend on the bottle size)
- ❒ Blue food coloring
- ❒ Recommended: plastic tape for taping the cap on the bottle
- ❒ Alternative to straws: battery operated or electric fan

Teacher Preparation: Try this activity yourself before doing it with students!
- ❒ Obtain materials above
- ❒ Depending on students, either have them prepare the wave bottles, or try to arrange for a parent volunteer to do so. To make the wave bottle:
- ❒ Obtain one bottle per group. The bottle should have a long tapered neck.
- ❒ Fill the bottle about a quarter full with corn syrup.
- ❒ Mix in a few drops of blue food coloring.
- ❒ Slowly pour in some vegetable oil until the thick part of the bottle is about half full.
- ❒ Cap the bottle tightly, and seal the cap with plastic tape.

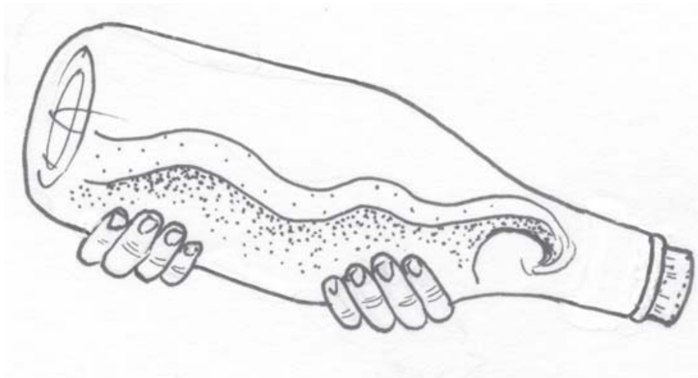
Procedure

Making Waves:
1. Ask students what they think causes waves.
2. Ask students what they predict will happen if wind blows across the surface of water.
3. Either demonstrate or have students experiment with forming waves by either blowing across the surface of water in a pan or using a fan to blow wind across the surface.
4. **If using an electric fan, caution students about the danger of water and electricity.**
5. Have students experiment (or demonstrate) with the fan on fast and slow speeds.
6. If using straws, have students blow on the water without straws, then with straws to concentrate the force. Have them blow hard and soft, and at different angles.



Slow Motion Ocean (continued)

Breakers:



1. Have the students slowly tip the wave bottles, observing what happens as the mixture approaches the narrow end, which simulates a coast getting shallower.
2. Call on students to describe their observations.

Discussion

1. See above.
2. Discuss the difference between wind-driven waves and tsunamis.
3. Discuss the effect of waves breaking on tide pool organisms, and on wave spray on zone 1.

Assessment

- Can students explain what causes waves and what causes waves to break?

References

Littlefield: *Awesome Ocean Science!*, p. 26
Project WET Curriculum Activity Guide, p. 450-451

Planet Water

Activity Summary

This Activity has two parts:

- In Part 1, students toss an inflatable globe around. When a student catches the globe, he or she reports whether their right thumb is on land or water. This information is recorded, and after 10 or 15 catches, the percentage of the Earth's surface covered with oceans is calculated.
- In Part 2, the teacher does a demonstration to show how much of the Earth's water is potable (drinkable).

Introduction

While we live on planet Earth, in reality most of the planet is covered with water. We artificially divide the Earth's ocean water into five oceans. In reality, the oceans are all interconnected and could be considered one ocean that covers about 70% of the Earth's surface.

While there is lots of water on the Earth, only a small fraction is unpolluted and available as liquid fresh water. Most of the water is either salty, frozen, far under the surface, or polluted.

Grouping:

Whole class

Time:

Part 1: 15 minutes
Part 2: 15 minutes

Anticipated Outcomes

Students will understand that the Earth has lots of water, but that only a small fraction is available for our consumption.
Students will understand the need to not pollute or waste fresh water.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.4.2; Math Number Sense 1.1, Measurement 1.1; Science Investigation 5.a-c
Grade 4 - S.S. 4.2.2; Math 3.1; Science Investigation 6.a-e
Grade 5 - Math: Measurement and Geometry 1.3; Earth Science 3.a
Grade 6 - Resources 6.b

Materials

Part 1:

- ❒ Inflatable globe
- ❒ White board, chalk board, or overhead projector

Planet Water (continued)

Part 2:
- ❒ 1000 mL beaker or 1 quart measuring cup
- ❒ 100 mL graduated cylinders
- ❒ Eyedropper/pipette or glass stirring rod
- ❒ Small metal bucket or other container
- ❒ Ice cube tray
- ❒ 2 small bowls, cups, or glasses
- ❒ Salt

Teacher Preparation: Try this activity yourself before doing it with students!
- ❒ Obtain materials

Procedure

Part 1: Activity:
1. Ask the students why Earth is called "Earth."
2. Ask them how much of the Earth they think is actually covered with water. Record answers on the board or overhead.
3. Show the inflated globe. Toss it up and catch it. Show the students where your right thumb tip is and point out whether it is on land or water. Repeat a couple of times.
4. Explain that the students are going to gently toss the globe to each other 10 times, each time recording whether the right thumb is on land or water. Repeat more times if by chance the ratio of water to land isn't nearly 7:3.
5. Discuss the significance of the fact that most of the Earth is covered by ocean water.

Part 2: Demonstration:
1. Show the students 1 L of water in a beaker. This represents all of the water on Earth.
   Ask what fraction of the total they think is fresh water.
2. Pour 30 mL into a 100 mL graduated cylinder. This 3% represents all of the Earth's fresh water. Put some salt into the 970 mL of water in the beaker.
   Ask students what fraction of the fresh water they think is frozen in ice caps and glaciers.
3. Pour 6 mL of the 30 mL into a small bowl and pour the other 24 mL into the ice tray.
   (The 6 mL is about 0.6% of the total liquid fresh water on Earth.) Ask what fraction of the 6 mL representing liquid fresh water the students think is drinkable surface water.
4. Use the dropper to drop 30 drops (about 1.5 mL … 1/4 of the liquid fresh water) into a small glass. This represents the fresh surface water: The rest is underground and unavailable to us or not drinkable.

Planet Water (continued)

5. Now take 1 drop of the 30 drops and dramatically show it as you release it into the bucket. This 1 drop, about 0.003% (3/1000 of one percent) of the total water, is available for people to use for drinking, washing, agriculture, and all other uses.

Step 1	1000 mL				
Step 2	970 mL salt water	30 mL fresh water			
Step 3		24 mL ice	6 mL liquid		
Step 4			4.5 mL underground	1.5 mL surface fresh	
Step 5				29 drops unavailable	1 drop available for human use

<u>Discussion</u>

1. Discuss why it is important for us to conserve our water.
2. Discuss the importance of not polluting water.
3. Discuss the effect of more people competing for the same fresh water.

<u>Assessment</u>

- Can the students explain that only a small fraction of the Earth's water is available for us to use for drinking, cooking, washing, etc?
- Can the students explain the importance of not wasting or polluting water?

<u>Resources</u>

Davenport: *Waves, Wetlands, and Watersheds*, p. 45-48
Project Wet, p. 238-241 (Has a table for converting mL to "standard," but why not teach metric?)

What is Salt Water?

Activity Summary

Students allow distilled, tap, and sea (salty) water to evaporate. They then examine and describe the residue (if any).

Introduction

Sea water is salty, i.e., it contains chemicals that are called "salts." To a chemist, the term "salt" includes many other chemicals besides common table salt or sodium chloride (NaCl). While the salts in ocean water contain many other chemicals, NaCl makes up the vast majority of sea salt. The other chemicals are important, though, as they provide nutrients for marine plants and protists.

The amount of dissolved salt(s) is called the salinity of a solution. Sea water is typically about 3.5% dissolved salts, which is often stated as 35 parts per thousand. Water can be more or less salty, though. It is interesting to ask students where the salt in the sea came from. When they realize that it was brought to the sea by streams, they can see that even "fresh" water streams must have some dissolved chemicals. Students who obtain their domestic water from wells may have experience with dissolved iron, sulfur, or other chemicals. River water averages about 0.02% salts.

Students may have heard about or even experienced the very salty water of the Great Salt Lake in Utah. Scientists believe that the Great Salt Lake was once part of an ancient fresh water lake called Lake Bonneville. Over the years, the waters of Lake Bonneville drained away or evaporated, leaving the Great Salt Lake behind. The size and salinity of the Great Salt Lake vary depending on the precipitation in its drainage basin. The Great Salt Lake is divided into two parts by an earthen railroad causeway. The salinity of the northern part varies from 16-27%, while the southern part ranges from 5-14% salt. The overall average is about 20%.

Salt (NaCl) is an important mineral for many reasons. As students study Native Americans, they often learn how they harvested salt from the coast for their own use and for trade. In some places in Africa, salt was sometimes literally worth its weight in gold. This can lead to a discussion of wants vs. needs. (We all need salt to live; gold is something that many people want, but isn't a necessity.)

Dietary salt doesn't come only as the salt that we buy as such, though. Salt is present in many of our foods.

Grouping

Variable, depending on materials available.

What is Salt Water? (continued)

Time

Day 1: 10-30 minutes.
Day 2: 10-30 minutes

Anticipated Outcomes

Students will understand that the water can dissolve some other substances and that the salts in the oceans are dissolved minerals.

Standard(s)

Grade 3 - S.S. 3.1.2, 3.2.2; Writing 2.2
Grade 4 - S.S. 4.2.1; Earth Science 5.a, 5.c, Life Science 3.b, 3.c, Investigation 6.a, 6.c
Grade 5 - S.S. 5.1.1; Physical Sciences 1.b, 1.h, 1.i, Earth Sciences 3.a, 3.b
Grade 6 - S.S. 6.1.1, 6.1.2; Ecology 5.b, Resources 6.b, 6.c

Materials

- ❒ Distilled water
- ❒ Tap water
- ❒ Well water with high mineral content (check with families, local drilling company, or water district)
- ❒ Sea water
- ❒ Saturated salt solution
  (“Saturated” means that no more salt will dissolve in the water. Make it by dissolving rock salt in warm or hot tap water in a gallon jug. Shake/stir, add more until no more will dissolve. Let it sit overnight. Add more salt until no more will dissolve with stirring. Rock salt is better for this than table salt, because table salt has chemicals added which will make the solution cloudy.)
- ❒ Evaporating plates:
  - Glass or plastic microscope slides or other thin, clear glass or plastic
  - Black or other dark colored plastic, maybe spoons - see teacher preparation
  - Chemists use glass “watch glasses” for evaporating dishes
  - Plastic Petri dishes (culture dishes) can be used for this and for many other experiments.
  - Black plastic caps from 35 mm. film “cans” can be used
- ❒ Medicine droppers (pipettes)
- ❒ Masking tape and pencils or wax pencils for marking
- ❒ Magnifying glasses or low power microscopes

Teacher Preparation: Try this experiment yourself before doing it with students!

- ❒ Obtain materials
- ❒ Depending on the students’ ages, you may want to mark the slides/plates to indicate what type of water was placed on them.

What is Salt Water? (continued)

- ❐ Use masking tape and pencil to label 2-3 droppers for each water type. (2-3 "tap water," 2-3 "sea water," etc.) This is to avoid contaminating one water sample with another type of water.

Procedure

1. Ask the students what they predict will happen if water is placed on a microscope slide or dark colored plate and allowed to evaporate overnight. Have them discuss this and write down their predictions.
2. Ask what will happen if sea water is allowed to evaporate. Have them record their predictions.
3. Show the various water samples and demonstrate how to:
   a. label the plates/slides so that they know what was there at the start
   b. put the same amount of each sample (20 drops) on different plates
   c. set the plates aside in a place where they won't be disturbed
4. Have students label the plates/slides with the various types of water samples.
5. Have the students place 20 drops (1 ml) of distilled water on one plate, 20 drops (1 ml) of tap water on another, etc. Caution the students not to switch the droppers around, as this will "contaminate" the samples.
6. The next day, have students use magnifiers to observe the plates and record their observations. (They should see mineral residues on some plates and, in some cases, salt crystals.)

Discussion

1. What causes the water to leave the plate?
   (Energy from the sun or other heat source causes water molecules to move rapidly enough to break free of attraction to other water molecules, which we call evaporating. Note: Just naming it "evaporating" doesn't show an understanding of the process.)
2. Where did the minerals come from?
3. What would happen to the salinity in a shallow tide pool on a warm day? On a rainy day?
4. Point out that plants and animals die if the water gets too salty. A fresh water fish can not live in the ocean. So, tide pool organisms must be adapted to survive a wide range of salinities.

Assessment

- Do the students follow directions when preparing their slides, observing, and cleaning up?
- Do the students record their observations clearly?
- Can students explain how the seas got salty?

Hot Stuff! Tide Pool Temperatures

Activity Summary

Students predict whether water temperature will change more in a small or large quantity of water. They then test their predictions, and compare temperature changes in water and sand.

Introduction

One important environmental factor with which tide pool organisms must contend is temperature changes. As compared to sand, water tends not to change temperature very much, as is shown by the cold temperatures along northern California's coast even on hot summer days. The water in tide pools, though, can change temperature significantly because the volume of water is relatively small, it is exposed to the air, and because tide pools tend to be dark in color, which increases the absorption of energy on summer days. Most marine organisms don't have to deal with large temperature fluctuations; intertidal organisms do. This is especially true of the organisms in the upper tide pool zones and of organisms such as algae, barnacles and mussels that are attached to the rocks. (Refer to pages 8-11 and 16.)

Grouping

Teams of 2-3 students

Time

15 minutes to start the experiment, then 30-60 minutes during which thermometers are read every 10 minutes. Discussion time.

Anticipated Outcomes

Students will know that water changes temperature relatively little when compared to sand under the same conditions.
Students will know that smaller quantities of water change temperature more than larger quantities under the same conditions.
Students will know that tide pool organisms must be adapted to a larger range of temperatures than organisms living in the open ocean.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.2.2; Writing 2.2; Physical Science 1.f, Life Science 3.d, Investigation 5.a, 5.b, 5.c
Grade 4 - Math 3.1; Life Science 3.b, Investigation 6.a-6.f
Grade 5 - S.S. 5.1.1; Math 1.3; Listening and Speaking 1.1; Earth Science 3.b, 3.c, 4.b, Investigation 6.a-6.i
Grade 6 - S.S. 6.1.2; Ecology 5.a, 5.e, Investigation 7.a-7.h

Hot Stuff! Tide Pool Temeratures (continued)

Materials

- ❒ 4 thermometers per group of students
- ❒ 4 plastic cups, baby food jars, beakers, or other containers per group
- ❒ Approximately 500 ml (2 cups) of sand and water per group
- ❒ Refrigerator
- ❒ Source of moderate heat…incandescent light bulbs, sunlight, hot plate, or?

Teacher Preparation (Try this experiment yourself before doing it with students!)

- ❒ Obtain materials.
- ❒ Practice the experiment yourself to see how long it will take your heat source and refrigerator to cause a significant temperature change in the sand.
- ❒ Decide on composition and numbers of student groups. To reduce the amount of material needed, you might have 2 groups compare large and small amounts of sand, 2 groups compare large and small amounts of water, 2 groups compare small but equal amounts of sand and water, and 2 groups compare larger but equal amounts of sand and water.

Procedure

1. Depending on the students' ability, either the students, a parent volunteer, or you: measure out equal amounts of sand and water into 2 containers for half of the groups. The amount needs to be enough to cover the bulb of the thermometer in the containers that the students will be using.
2. In two other containers, measure out twice the amount of sand and water as in step 1. These larger quantities will be tested by other groups.
3. Discuss with the students whether they think that equal amounts of water and sand will change temperatures the same amount if exposed to a heat source and/or refrigeration.
4. Discuss with the students whether they think the larger quantities of sand and water will change temperature as much as the smaller quantities.
5. Have the students write down their predictions for both sand compared to water and different quantities.
6. Either provide the students with a data table such as the one on the next page or have them design a similar data table.

   Predictions:

   a. I predict that sand will change temperature (more or less…circle) than water when equal amounts are placed in a refrigerator.
   b. I predict that sand will change temperature (more or less…circle) than water when equal amounts are heated equally.
   c. I predict that a larger amount of sand will change temperature (more or less…circle) than a smaller amount of sand when placed in a refrigerator.
   d. I predict that a larger amount of water will change temperature (more or less…circle) than a smaller amount of water when both are heated equally.

Hot Stuff! Tide Pool Temeratures (continued)

Time	Temp. of small sample of sand	Temp. of large sample of sand	Temp. of small sample of water	Temp. of large sample of water
Start (0 minutes)				
+ 10 minutes				
+ 20 minutes				
+ 30 minutes				
+ 40 minutes				
Temp. change				

7. Have the students decide on time intervals at which to check the temperatures.
8. Be sure that the students know how to read the thermometers…Teach them if necessary.
9. Have the students measure and record the **starting** temperatures of the sand and water samples in the containers.
10. Have the students place one large and one small of both sand and water in the refrigerator and the others near the heat source.
11. At the agreed upon intervals, have the students check and record the temperatures of the samples.
12. After the experiment is finished, collect the sand for use in other experiments, and have the students rinse out the sand containers.
13. Have the student groups share their results. Record the results on the board or an overhead transparency of the data table.
14. Discuss, including the significance to tide pool organisms.

Discussion

1. Discuss the significance of this experiment to tide pool organisms.
2. Discuss the changes in the temperature of the sand at the beach on a summer day as compared to the water's temperature change.
3. Discuss the implications on weather in the U.S. Coastal climates tend to be moderated by the oceans. For a given latitude, the temperature extremes tend to be in places far from the ocean.
   (You might bring in a newspaper with national temperature data and compare the Mendocino coast, Denver, and Helena, Montana. It is also interesting to compare Fairbanks and Anchorage, and Mendocino or Fort Bragg to Ukiah or Lakeport.)

Hot Stuff! Tide Pool Temeratures (continued)

4. Optional: While on a field trip to the tide pools, have students check the temperature near the surface and near the bottom of a tide pool that has been exposed to the sun for a while. Better yet: Have them check the top, middle, and bottom temperatures over a period of a few hours.

Assessment

- Do the students demonstrate their ability to use the thermometers properly?
- Can the students tell that small quantities of water change temperature more than large quantities, other things being equal?
- Can the students tell that sand will change temperature more than water, other things being equal?
- Can the students discuss the significance of tide pool size and exposure with regards to tide pool organisms?

Drying Out in the Water?

Activity Summary

Students place pieces of carrot in the air, tap water, sea water, saturated salt solution, and salt. They then observe the carrot pieces the next day and observe changes in size and turgidity (rigidity).

Introduction

Few fresh water organisms can live in ocean water, and few marine organisms can survive in fresh water. One reason for this is osmosis, or movement of water across a semi-permeable membrane such as a cell membrane, from an area of high concentration (of water) to the other side of the membrane where there is a lower concentration of water. Most fresh water organisms will lose water from their cells if placed in sea water. If they lose too much water, they die.

Tide pool organisms, especially those in small pools in the upper zones, must be able to either leave the tide pool or deal with very salty water on a warm summer day when water evaporates from the pool, or with water that is less salty than ocean water on a rainy day. Some deal with this varying salinity by clamping down on rocks or closing shells. Others have tough skins that aren't very permeable to water. Others have a high tolerance for a range of salinities.

Grouping

Groups of 2-4 students

Time

Day 1: 10-30 minutes
Day 2: 15-30 minutes + discussion

Anticipated Outcomes

Students will understand that water can move in and out of cells and organisms.
Students will understand that losing too much water is harmful to an organism.
Students will understand that tide pool organisms must have adaptations for dealing with a variety of salinities.

Standard(s)

Grade 3 - Writing 2.2; Math: Number Sense 1.1, Measurement and Geometry 1.1; Life Science 3.a, 3.b, 3.d, Investigation 5.a, 5.c
Grade 4 - Life Science 3.b, 3.c, Investigation 6.a-6.f
Grade 5 - Math: Measurement and Geometry 1.3; Physical Science 1.i, Earth Science 3.a, 3.b, Investigation 6.b-i
Grade 6 - Ecology 5.e, Investigation 7.a-7.h

Drying Out in the Water? (continued)

Materials

- ❒ Paper and pencils
- ❒ Rock salt and table salt
- ❒ Carrots ("baby carrots?")
- ❒ Knife (teacher or parent volunteer uses)
- ❒ 5 similar containers for each group: plastic cups, baby food jars, beakers, or?
- ❒ 6" of masking tape or some other way to label containers
- ❒ Optional: ruler with millimeters

Teacher Preparation (Try this experiment yourself before doing it with students!)

- ❒ For each group, cut 5 carrot slices of approximately equal diameter and thickness. "Baby carrots" are good for this because their sides are less tapered than fresh carrots, and they have had the outer layers removed.
- ❒ Alternatively, use large carrots and cut cubes of equal size. This may be preferable if you choose to have the students measure the sides of the carrots and calculate volume.
- ❒ Either obtain some sea water or prepare an artificial sea water sample by dissolving about 28 grams (1 ounce) of table or rock salt in a liter (quart) of water.
- ❒ Make a saturated salt solution by adding salt to a liter of warm water until no more will dissolve, then add more. Let this stand overnight, and add more if all of the salt has dissolved. Keep doing this until no more will dissolve. Regular table salt will produce "cloudy" water; rock salt is recommended.
- ❒ Either put together sets of materials for the students or set up stations where they will pick up their materials. Each group will need the following:
    - 5 containers such as plastic cups, baby food jars, Petri dishes, or beakers
    - Tap water, sea water, saturated salt solution, dry table salt
    - Pencil (not pen, as pen will run if it gets wet while pencil won't)
    - White paper
    - 6 inches of masking tape or some other way to label the containers
- ❒ Consider starting this experiment late one day and finishing it the next morning.

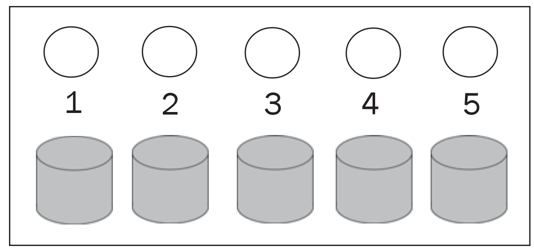
Procedure

1. Ask the students to tell what they think would happen to a fresh water animal if it were put into the ocean.
2. Ask the students what they think would happen to an ocean animal if it were placed in a fresh water lake.
3. Ask the students to predict, in writing, what they think would happen to a piece of carrot if it were put overnight in ocean water, very salty water, dry salt, tap water, and the air.

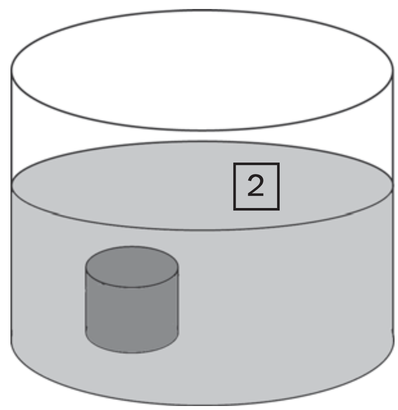
Drying Out in the Water? (continued)

4. Explain the following procedure to the students, using materials to demonstrate:
   a. Use masking tape to number the 5 containers. Place the following into the containers:
      #1: nothing (air)
      #2: tap water (approx 1" deep)
      #3: 1"of sea water
      #4: 1" of saturated salt solution
      #5: nothing yet…will add dry salt after the carrot piece is in the container

   b. Place 5 carrot disks on a piece of paper and draw around each of them with a pencil. Be sure to keep track of which piece goes with each circle by numbering the circles to correspond with the 5 numbered containers.



   c. Place the carrot disks into the containers, being sure that the numbers correspond. For #5, place the carrot disk in and cover it with table salt. Set the experiment aside where it won't be disturbed.



   d. The next day, have students observe the containers/carrots, then have them remove the carrot disks and record their observations about both their size and turgidity (stiffness).
      - Students should notice that the carrot disk in the saturated solution is floating, while the others are on the bottom. This is because the saturated salt solution is denser than the carrot disk.
      - They might measure the diameters, or simply place the disk on the corresponding circle drawn the day before.
      - For older students, consider having them calculate the volume before and after.

Drying Out in the Water? (continued)

5. After the students have recorded their observations, discuss the observations and the implications for organisms. (Do this before cleaning up, so you can show examples.)
   Typical results might be: (water moves from a high density [%] of water to where there is a lower % of water)
   Carrot in air - will lose about 1/3 of its diameter and become soft (air has little water in it)
   Carrot in tap water - will stay the same, and may become more turgid/firm (higher % water outside carrot)
   Carrot in sea water - will lose about 1/10 of diameter and become softer (lower % water outside carrot)
   Carrot in saturated salt solution - will lose a little more, become softer, and float (still lower % water outside, and carrot cellulose tissue is less dense than water)
   Carrot in dry salt - will lose about 1/3 of its diameter and become soft (water diffuses out into salt)

<u>Discussion</u>

1. Why did some of the disks shrink? (Water left the cells because there was more water (a higher percentage) in them at the start than in the surrounding water (or air or salt), so more molecules were moving outward from the cells than inward. This is called osmosis.
2. Why didn't the tap water disk shrink? (water entered cells as fast as it left)
3. Why did some carrots get soft? (water left the cells)
4. What would happen to a fresh water animal placed into the ocean? Why can't people on a life raft in the ocean just drink the ocean water?
5. What would happen to an ocean animal placed in fresh water?
6. How might tide pool organisms deal with a salty pool on a sunny day? With a tide pool that was becoming more diluted (less salty) during a rain storm?

<u>Assessment</u>

- Can the students discuss the above questions?

Wet is Wonderful!

Activity Summary

Students experiment to determine how well various covering materials will delay the drying out of a sponge. This is to demonstrate the importance of re-covering organisms after moving a rock or clump of algae to examine them.

Introduction

One of the most important limiting factors for tide pool organisms is the drying effect of exposure to the air. Many organisms obtain oxygen through gills, which, like our lungs, must be kept moist. When students explore the tide pool area, they will generally turn over rocks and clumps of algae ("sea weed") to look for organisms. This, of course, exposes the organisms underneath not only to desiccation, but also to capture by predators, injury from the students, and injury both from the removal and the replacement of the rock or algae.

Grouping

2-4 students per group

Time

Time will vary depending on a number of things, including air temperature, wind, type of soil or sand, and other factors. Start the activity in the morning and check the experiment periodically throughout the day.

Anticipated Outcomes

Students will understand the importance of being careful when moving rocks or algae at the tide pools.

Students will understand the importance of replacing rocks and algae after moving them to look for organisms.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2, 3.4.2; Writing 2.2; Physical Sciences 1.f, Life Science 3.a, 3.d, Investigation 5.a. 5.b

Grade 4 - Life Science 3.a, 3.b, 3.c, Investigation 6.a-f

Grade 5 - S.S. 5.1.1; Life Sciences 2.a, Earth Sciences 3.b, 3.c, 4.b, Investigation 6.b-i

Grade 6 - Ecology 5.e, Investigation 7.a-7.h

Materials

- ❒ Thin pieces of sponge or paper towels or cloth towel scraps: 3 per group
- ❒ Water
- ❒ Sand or soil in plastic pans or cardboard boxes lined with waxed paper (or area outside where experiments will not be disturbed)

Wet is Wonderful! (continued)

- ❒ Rocks, approximately 5" x 7" or ?: 1/group
- ❒ Clumps of algae, large, flexible leaves (not dry), or cloth torn into strips to simulate clumps of algae (If you obtain algae from the coast, you may be able to dry it thoroughly after the experiment and store it for future use.)
- ❒ Half of a rinsed out egg shell
- ❒ Recommended:
  "Cobblestone Hotel" transparencies from *Once Upon a Seashore* by Snively.

Teacher Preparation

- ❒ Either cut out small sponge pieces (approx ½" thick x 1"x 2") or make paper towel or cloth pieces about 4" x 4."
- ❒ If doing the activity inside:
  Obtain plastic pans (1/group) or line cardboard boxes with waxed paper, plastic, or foil.
  Fill the pans or boxes with approximately 2" of dry soil or sand each.
- ❒ If doing the activity outside:
  Find a place where the experiments can be set up and not be disturbed.
- ❒ Obtain clumps of algae, or leaves, or simulate algae with strips of damp cloth.
- ❒ Obtain a half of a rinsed out egg shell for each group.
- ❒ Try out the experiment yourself a day or two before the students do the experiment. This will enable you to decide on appropriate intervals for checking the sponges. If it is warm and dry, you may want to have them checked every 15 minutes. If it is cool and humid, you may only need to check every 45 minutes.
- ❒ Recommended: Make transparency of "Cobblestone Hotel" masters from Snively.

Procedure

1. Discuss the importance of organisms remaining moist to tide pool animals.
2. Ask the students how long a tide pool animal might remain moist if it is uncovered by someone moving a rock or clump of algae.
3. Describe the experiment to the students, or ask them how they might use the materials to design an experiment.
4. Either provide the students with a data table like the one on the next page or have them create their own.
   Descriptors: wet, very damp, damp, slightly damp, dry
5. Have the students write down their predictions for how long they think it might take a piece of damp sponge (or paper towel or cloth towel) to dry out if it is exposed to the air, under a rock, and under some algae.
6. Have each group moisten three sponge pieces (or folded up towel pieces).
7. Have the students place half of an egg shell on the soil or sand to simulate an organism.
8. Have the students place one of their sponges on top of the moist soil or sand, and the others under the rock and the algae clump (or leaves or damp cloth strips).

Wet is Wonderful! (continued)

9. Check the sponges every 15-30 minutes, recording whether they are wet, very damp, damp, slightly damp, or dry.

Discussion

1. How close were the predictions?
2. Which provided better protection from drying out: rock or algae?

Time	Exposed to air	Under rock	Under "algae"	Condition of eggshell
Start (0 minutes)				
+ 15 minutes				
+ 30 minutes				
+ 45 minutes				
Etc.				

3. Why is it important to carefully replace rocks or algae clumps?
4. Use the "Cobblestone Hotel" overhead transparency to discuss the various kinds of organisms that live on and under rocks and why it is important to be careful when moving or even walking on rocks in the tide pool area.

Assessment

- Are the students able to explain why it is important to carefully replace rocks or algae?

References

Snively: *Beach Explorations*, p. 73-79 and *Once Upon a Seashore*, p. 97-103

Now You See Me, Now You Don't

Activity Summary

Students experiment with paper "fish" and find that camouflage is an adaptation that helps fish (and other organisms) avoid getting caught by predators.

Introduction

Intertidal animals need to contend with many things, and predators are a constant threat to most. Animals have evolved a variety of ways of defending against predators, including sharp pinchers, stinging cells, hard shells, the ability to flee quickly, and camouflage. Many organisms combine camouflage with other defenses.

For predators, camouflage is not only a defense against other predators, but also a way to sneak up on their prey.

Grouping

Groups of 3 students

Time

10-30 minutes, including discussion

Anticipated Outcomes

Students will be able to define camouflage and tell how it helps animals survive. While at the tide pools, students will be able to point out examples of camouflage.

Standard(s)

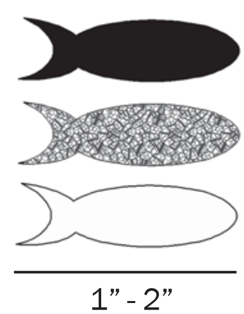
Grade 3 - Writing 2.2; Life Science 3.a, 3.b, 3.d, Science Investigation 5.a-5.c
Grade 4 - Life Science 3.a, 3.b, Science Investigation 6.a
Grade 5 - Science Investigation 6.a-f
Grade 6 - S.S. 6.1.1, 6.1.2; Ecology 5.a-5.e

Materials

- ❐ Scissors
- ❐ Newspaper (classified section)
- ❐ Colored and white construction paper
- ❐ 2 envelopes per group

Teacher Preparation

- ❐ Cut out (or have a parent volunteer do it) paper "fish" from the classified section of a newspaper and from colored construction paper. Make about 20 newspaper and 20 colored (light and dark) construction paper "fish" per student group.

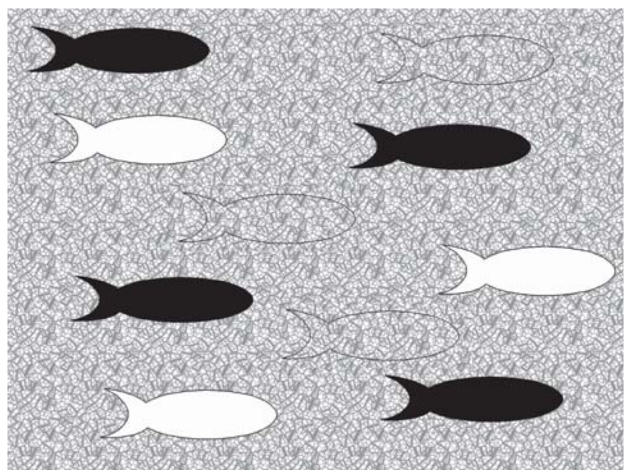


Now You See Me, Now You Don't (continued)

❒ Put together "sets" of materials that include:
- ½ page of newspaper classified section
- 1 colored and 1 white sheet of construction paper
- An envelope with 20 newspaper "fish"
- An envelope with 20 construction paper "fish" (of the same color as the sheet)

Procedure

1. Issue sets of materials to student groups (3 students per group). One student is designated as the predator and the other(s) as "mother nature."
2. Have the "predator" student turn around while the others scatter both the newsprint and colored construction paper fish on the sheet of newsprint.
3. Tell the other student (the predator) that on "go" they are to turn around and pick up as many of the fish as they can in 10 seconds, ONE AT A TIME, using only the thumb and forefinger of one hand.
4. Start the "hunting" with "Go!" and stop the hunting after 10 seconds.
5. Have the students count and record how many newsprint fish and how many colored fish they collected from the newsprint background.
6. Designate a different student as the predator and have them repeat the above with the colored construction paper as a background.
7. Designate the third student as the predator, and have them repeat the above with the white paper as a background.
8. Tally the class data for each trial on the board or overhead projector.



Discussion

1. Which type of fish "survived" best in each trial?
2. Which type of fish would have been able to produce the most offspring in each trial?
3. How does camouflage help the individual survive?
4. How does camouflage help the species survive?

Assessment

- Can the students define camouflage?
- Can the students explain how camouflage helps the individual and the species survive?
- Can the students point out examples of camouflage at the tide pool?

Other Activities

Virtual Field Trip

While you are previewing the trip, you might take slides or make a video. These can be used to help prepare the students for the trip through a "virtual field trip" in which the students see pictures of many of the organisms that they will see on the trip. This preview will help the students know what to expect without diminishing their excitement and interest. Students enjoy seeing an organism in real life after seeing it in pictures, and they are more likely to remember it.

A virtual field trip can also be used to review what was seen at the coast. You might have the students prepare a slide show of their trip for parents … maybe a digital slide show using *Power Point*?

There are several good DVDs and video tapes about the intertidal zone. See Appendix D - Resources.

Standard(s)

Grade 3 - S.S. 3.1.1; Life Science 3.a-d
Grade 4 - S.S. 4.2.2; Life Science 3.a
Grade 5 - S.S. 5.1.1; Life Science 2.a, Earth Science 3.c
Grade 6 - S.S. 6.1.2; Earth Science 1.f, 2.c, 2.d

Research Teams of Experts

Some teachers prepare their students by forming teams, with students becoming "experts" on certain organisms before the trip. One student may learn about crabs, another about algae, and another about anemones. The teacher can provide information, or the students can do research in the library or on the Internet. The information in this guide, including the resources listed at the end will be useful. While on the trip, they can share their knowledge with their team mates.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a
Grade 4 - Life Science 3.a, 3.b, 3.c, Science Investigation 6.a
Grade 5 - Writing 2.3; Life Sciences 2.a, Science Investigation 6.a
Grade 6 - Ecology 5.a-e

Notebooks and Journals

Students can prepare for the trip by making notebooks or journals in which to record their observations. Students might:

- Sit quietly and observe an organism … describe behaviors or draw.
- Describe and draw one or more adaptations that organisms exhibit.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a-d
Grade 4 - Life Science 2.b, 2.c, 3.a-c, Investigation 6.a-c
Grade 5 - Writing 2.3; Life Sciences 2.a, Earth Sciences 3.a-d
Grade 6 - Writing 2.3; Earth Science 1.f, 2.c

Checklists

Teachers can provide checklists of things for the students to look for. Two examples are given below. (See pages 107-108.)

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, 3.b, Science Investigation 5.a
Grade 4 - Life Science 3.a, 3.b, Science Investigation 6.a
Grade 5 - Life Sciences 2.a, Science Investigation 6.a, 6.g
Grade 6 - Life Sciences 5.c, 5.e

Sea Shore Organisms Checklist

Which of these organisms have you seen before going on the field trip to the rocky coast pools? Which organisms do you see on the trip?

Organism	Before field trip?	On field trip?	Notes or Sketches:
Sea Palm			
Rockweed			
Coralline Red Algae			
Surf Grass			
Giant Green Sea Anemone			
Acorn Barnacle			
Lined Shore Crab			
Hermit Crab			
Chiton			
Gumboot Chiton			
Limpet			
Abalone			
Turban Snail			
Mussel			
Ochre Star			
Bat Star			
Sea Urchin			
Cormorant			
Sea Gull			

Seashore Organism Adaptations Checklist

Which of the following adaptations have you seen before? Which do you see while on the field trip to the rocky coast?

Adaptation	Before field trip?	On field trip?	Example from trip:	Notes or Sketches:
Flexible stalk or stem				
Streamlined shape				
Glue for attaching to rock				
Hard shell				
Biting mouth parts				
Pinchers				
Tentacles that sting				
Camouflage				
Hiding in holes or cracks				
Hiding under algae or sand				
Ability to move quickly				

Sensory Awareness

We tend to be very sight oriented. Students can be encouraged to use other senses. One way to do this is to have students complete a Sensory Awareness Chart. This, of course, can be extended to other environments, including the classroom, playground, home, or other places. This can also be used to help teach about similes and metaphors. Space has been left in the charts below for students or teachers to add items.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, 3.b, Science Investigation 5.a-c
Grade 4 - Science Investigation 6.a-b
Grade 5 - Listening and Speaking 1.1; Life Sciences 2.a, Science Investigation 6.a, 6.g
Grade 6 - Math Statistics 2.1, 2.2

Sense of Touch

How many of these have you felt?	Before field trip?	On field trip?	Notes or Sketches:
Sliminess of wet algae			
Sharp points of a barnacle			
Wood grain on driftwood			
Ridges on a mussel shell			
Tickling of a hermit crab walking			

Sense of Hearing

How many of these have you heard?	Before field trip?	On field trip?	Notes or Sketches:
Waves crashing against rocks			
Waves breaking on a sandy beach			
Seagulls calling			

Sensory Awareness (continued)

Sense of Smell

How many of these have you smelled?	Before field trip?	On field trip?	Notes or Sketches:
Sea air			
A dead animal on the beach			
A wet feather			
Moist soil near the beach			

Sense of Taste

How many of these have you tasted?	Before field trip?	On field trip?	Notes or Sketches:
Crab			
Abalone			
Shrimp			
Fresh algae			
Dried algae			
Clam chowder			
Squid (calamari)			
Sea urchin eggs (roe)			

Sensory Awareness (continued)

Sense of Sight

How many of these have you seen?	Before field trip?	On field trip?	Notes or Sketches:
Individual grains of sand			
Grain in driftwood			
Star pattern on sea urchin or sand dollar			
Coiled chambers in a broken snail shell			
Anemones waving their tentacles in the water			
A sea star walking			
Rainbow colors on wet algae			
Sand and shells on an anemone			
Crabs running sideways to hide			
Fish darting for cover			

<u>Reference</u>

Snively: *Once Upon a Seashore*, p. 234-237

Lessons and Activities to do During the Tide Pool Field Trip

While on the trip, the safety of both the students and the environment are of utmost concern. For this and other reasons, it is important that the teacher preview the trip, preferably with a ranger or interpretive specialist.

While at the tide pools, the emphasis should be on doing learning activities that cannot be done elsewhere.

Hands-On Activities

Litter Getters

Before leaving the beach, have students collect any litter that they can find. Caution them about sharp glass or metal, fish hooks, syringes, or other dangerous items. After they have collected the litter, have them sort it into categories. Discuss what people could have done rather than pollute the beach. Dispose of the material properly, recycling what you can.

Standard(s)

Grade 3 - S.S. 3.4.2; Math Number Sense 1.1; Writing 2.3
Grade 4 - Math 3.1
Grade 5 - Science: Investigation 6.g
Grade 6 - Science Resources 6.b, 6.c

References (See the “Resources” section at the back of this *Guide*)

Armstrong: *Sea Searcher’s Handbook*, p. 189-195
Brown-Babcock: *Save Our Seas*, the whole thing!
California Coastal Commission, especially the Adopt-A-Beach program

In the Zone

Activity Summary

This activity can be done before or after the students have been taught about zonation.

While at the coast, students are asked to look carefully at an area that shows bands of different algae types, mussels, anemones, etc., *i.e.*, an area or rock that shows zonation. The teacher leads the students to notice the zonation and then discusses what might cause the organisms to form the bands/zones.

Introduction

Different organisms have different tolerances for such things as exposure to the air, variations in temperatures, and wave action. As a result, intertidal organisms tend to form bands called zones, based on which organisms can tolerate and thrive in the physical environments at various levels in the intertidal area. Scientists generally describe 4 zones in the intertidal environment. See pages 8-11.

Grouping

Whole class or smaller groups

Time

5-15 minutes, depending on the students' prior knowledge and their ability to observe the zones

Anticipated Outcomes

Students will understand the reasons behind zonation in the tide pool ecosystem.
Students will develop their ability to distinguish between various organisms.
Students will increase their ability to describe organisms and zones.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, 3.b, 3.c, 3.d, Investigation 5.a
Grade 4 - Life Science 3.a, 3.b, 3.c, Investigation 6.a-d
Grade 5 - Listening and Speaking 1.1, 1.2; Life Sciences 2.a, Investigation 6.h
Grade 6 - Ecology 5.e

Materials

- ❒ None needed
- ❒ Optional: Binoculars

In the Zone (continued)

Teacher Preparation

- ❒ The teacher must preview the field trip site, preferably with the ranger or interpreter that will be working with the students. Select a point from which the students will be able to clearly see the pattern of bands of organisms indicating the zones.

Procedure

1. Gather the students at the point from which the zonation is easily seen.
2. Ask the students what they notice about the organisms living on the rocks.
3. Lead the students to observe the zonation.
4. Ask the students to hypothesize about why the organisms grow/live in bands.

Discussion

1. What do you notice about the way that the different kinds of organisms are arranged?
2. Have you ever been to the Sierra Nevada Mountains? Are the pine trees and cones the same there as at the coast (in the Sierra, students will have seen several kinds of pine cones, including large sugar pine, smaller lodge pole pine, and medium Jeffrey and Ponderosa; at the coast, the most common is the Monterey Pine, which has medium sized cones.)
3. If you have plants at your house, or a garden, do some plants do better in shade than in sun, and vice verse?
4. Are jungle plants and animals the same as desert plants and animals?
5. What determines which organisms will be able to live in a place?
6. What would happen to an organism that was moved from its normal home (zone) to another?

Assessment

- Do the students notice the bands?
- Can they form reasonable explanations for the bands of organisms?

Holdfast Hideouts

Activity Summary

Students examine an alga holdfast, looking for organisms living under, in or on it.

Introduction

The convoluted shape of kelp holdfasts makes them ideal hiding places for small worms, snails, crabs, and many other organisms. Not only are organisms found in the many nooks and crannies, but they seek shelter under the alga mass itself.

Grouping

Grouping will depend on the numbers of algal clumps/holdfasts, pans, and magnifiers. Groups of 2-4 students are recommended.

Time

10-30 min +

Anticipated Outcomes

Students will increase their observation abilities.
Students will learn about organisms' adaptations, especially camouflage.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, 3.b
Grade 4 - Life Science 2.a, 2.b, 2.c, 3.b, 3.c, Investigation 6.a
Grade 5 - Life Sciences 2.a, Investigation 6.a
Grade 6 - Ecology 5.a-5.e

Materials

For each team of students:

- ❒ aluminum pie tin, plastic or metal pan, preferably with white bottom
- ❒ plastic magnifiers
- ❒ plastic forceps
- ❒ a cloth towel for drying hands and materials

Teacher Preparation

- ❒ Obtain and prepare materials.
- ❒ If the pans don't have white bottoms, white paper or poster board can be cut to fit. Butcher paper, with the coated side up works well.
- ❒ Attach strings to the plastic magnifiers so that they can be worn around the neck.

Holdfast Hideouts (continued)

Procedure

Before the trip:

1. Consider having students practice with the materials in the classroom before going to the coast. Emphasize safety and not losing equipment.
2. Also emphasize that many of the organisms that they will find will be very difficult to see. Discuss the value of camouflage.

During the trip:

1. This activity might be done after exploring the tide pools, as it requires the students to focus closely.
2. Find (or have the students find) several clumps of algae, preferably but not necessarily, with holdfasts.
3. Place the algae into pans, and have students look carefully for creatures hiding there.
4. Students can sketch or describe (in writing or verbally) what they find.
5. Emphasize taking care of the organisms. Keep them damp, return to where they were found.

Discussion

1. Discuss the value of camouflage. What would happen to an organism that isn't well hidden?
2. Discuss the use of the algae as food, shelter from drying out, shelter from predators.
3. What happens to the dead algae? (food for various organisms, including decomposers)

Assessment

- Are the students taking the time and effort to look closely?
- Can they define camouflage and give an example?

References

Brown: *Exploring Tidepools*, p. 19

The Pyramid of Numbers

Activity Summary

Before the field trip, students are asked to predict the relative numbers of various kinds of organisms they will see. While on the field trip, they note and discuss how many they actually see. Presumably, they will see fewer top carnivores than they will herbivores in a given area.

Introduction

The farther “up” a food chain one goes, or the closer to the top of a food pyramid, the fewer the organisms. This is due to the fact that organisms are not 100% efficient in converting their food to their own tissue. Most of the energy and matter that organisms take in is returned to the environment. (Consider how much food you eat each day. How much weight would you gain if you converted even 25% to your own body tissue each week?) This reduction in numbers (and mass) of organisms as one goes up the food chain is called the “pyramid of numbers,” “pyramid of biomass,” or “food pyramid.” See pages 26-27.

Grouping

Tide pool groups

Time

5 minutes to observe and discuss

Anticipated Outcomes

Students will understand the concept of the pyramid of numbers/biomass.
Students will understand why a given area of land can support more herbivores than carnivores.

Standard(s)

Grade 3 - S.S. 3.1.2, 3.2.2, 3.4.2; Math 1.1; Writing 2.2; Life Science 3.c, 3.d
Grade 4 - S.S. 4.2.1; Life Science 2.a, 2.b, 2.c, 3.b, 3.c, Investigation 6.a, 6.b. 6.c
Grade 5 - S.S. 5.1.1; Investigation 6.a, 6.b, 6.g, 6.h
Grade 6 - S.S. 6.1.1, 6.1.2; Math 2.1, 2.2; Writing 2.2; Ecology 5.a-5.e

Materials

None needed

Teacher Preparation

None needed

The Pyramid of Numbers (continued)

Procedure

Before the trip:

1. Identify some of the organisms that students are likely to see on the tide pool field trip. List the organisms on the board and discuss the idea that there won't be equal numbers of each kind of organism in a tide pool. (Try NOT to let students who have been to tide pools before tell the rest of the class about the relative abundance of the organisms.)
2. Have the students copy the list (or use the data table below), and have them, as individuals, indicate (write) whether they think they will see very few, few, many, or very many in a given tide pool.

During the trip:

1. Select a typical tide pool in which the students can see several of the organisms.
2. Have them estimate how many of each are in the tide pool.
3. Have the students record the relative numbers on their data tables.
4. Discuss

Organism	Type of organism (producer, herbivore, carnivore)	Relative # or amount (mass) predicted	Relative # or amount (mass) observed
Algae			
Turban snail			
Limpet			
Mussel			
Crab			
Sculpin (fish)			
Octopus			

Relative amounts:

0 = none
1 = very few/very little mass
2 = few/little mass
3 = many/lots
4 = very many/quite a lot

The Pyramid of Numbers (continued)

Discussion

1. Students will probably see that there is more mass of algae than of animals, and that there are more herbivores than carnivores. Discuss the idea that animals are not 100% efficient in converting their food to their body masses.
2. Discuss also the significance of this with regards to how many people the Earth can support. If people ate only plants, a given amount of farm land could support more people. In the United States, a lot of corn, wheat, and other plants that could be eaten by people is fed to cattle so that people can eat the meat.
3. Point out that the phytoplankton and zooplankton, which they won't see without a microscope, are extremely important parts of the intertidal ecosystem.

Assessment

- Can students explain why there are generally fewer carnivores than herbivores?

Reference

Roa: *The Environmental Science Activity Kit*, p. 158

Sea Star Surprise…How Does That Grab You?

Activity Summary

Students look closely at the tube feet and pedicellariae (singular: pedicellaria) of a common Ochre Sea Star (*Pisaster*).

Introduction

Sea stars (a.k.a. starfish) and their relatives have several unique adaptations. The Ochre Star (*Pisaster*) is common in the tide pools and is a good animal to examine closely. However … **Do not pull on it hard to pick it up.** If the sea star doesn't come off easily, leave it be. Sea stars attach themselves to rocks and mussel beds with thousands of "tube feet," which work like suction cups. Pulling hard on an attached sea star may tear many of those tube feet, which the animal needs for walking and capturing food.

The sea star uses its tube feet when feeding. It attaches itself to the two shells of a clam or mussel with hundreds of its tube feet. The combined pulling power and endurance of hundreds of tube feet is enough to overcome the power of the one or two muscles of the mussel or clam, which eventually open their shells a small amount. The sea star then everts its stomach (turns it inside out) into the shell, digesting the mussel in its own shell.

Even without picking up a sea star, students can discover the tiny pedicelliariae, which are tiny pincher-like structures on its back. The sea star uses its pedicellariae to remove bits of matter or even other organisms that settle onto its back.

Grouping

The whole class or group should examine the same sea star so that others don't have to be disturbed.

Time

5-10 minutes per class

Anticipated Outcomes

Students will observe tube feet and pedicellariae.
Students will increase understanding of some adaptations.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, 3.b, Investigation 5.a
Grade 4 - Life Science 2.b, 2.c, 3.b, Investigation 6.a
Grade 5 - Listening 1.h; Life Sciences 2.a
Grade 6 - Investigation 7.a

Sea Star Suprise...How Does That Grab You? (continued)

Materials

- ❒ Plastic magnifiers
- ❒ Plastic/rubber pipette/”eyedropper”

Teacher Preparation

None needed

Procedure

Before the trip:

1. Discuss this activity with the ranger or interpreter who is leading the trip.
2. Decide whether to do it or not, and who will lead it.

During the trip:

1. Find a sea star such as the ochre star, *Pisaster*. Have the **students observe it in place.**
   If the sea star can be removed from the rock or mussel bed **easily** (without tearing tube feet), the **teacher** may **gently** remove it and show it to the students.
2. Have the students use a magnifier to observe the tube feet. Explain that they act like tiny suction cups to attach the sea star to rocks or mussel shells. Explain the sea star feeding process of everting its stomach and digesting the mussel in its shell.
3. Students can gently lay their forearm on top of a sea star, whether the sea star is attached to the rock/mussel bed or not. Have the student leave his or her arm in place, gently touching the dorsal (back/top) surface for several seconds. When the arm is removed, it will feel like it is stuck to the sea star. This is caused by the pincer-like pedicellariae grabbing the hair of the arm. Essentially, the sea star is treating the arm as if it were a piece of litter that fell on the sea star’s back! Have students observe the pedicellariae with their magnifiers.

Discussion

1. Discuss the points mentioned above.

Assessment

- Do students refrain from pulling organisms, including sea stars, off of the rocks?
- Can students explain the functions of tube feet and pedicellariae?

Reference

Brown: *Exploring Tidepools*, p. 41

Other Activities

The curriculum resources listed in Appendix D (page 158) provide numerous activities that can be done at the coast. Students should be allowed to have as much time as possible actually observing the organisms.

Sometimes there is enough time for students to have some time to sketch, write poetry, write in a journal, or simply think about the tide pool experience before returning home.

Alone Activities

If there is some time, I recommend that the students be given some alone time. Maybe have them spread out where the teacher or other adult can see them but far enough apart to discourage talking. Give a simple assignment such as:

- Sketch your favorite tide pool organism and tell why it's your favorite.
- Write a brief note to a tide pool organism. Tell the organism what you liked, or what you learned, or what you wonder about.
- Write a short poem about what you saw or learned today.
- Write a note to your parents. Tell them something about the tide pools.
- Sit quietly, close your eyes, listen and smell. Arrange to have an adult tell you when 5 minutes are up. Write down what you heard, felt, and smelled.
- Go to a spot that is "natural" (not a park bench or parking lot). Spend 5 minutes looking as closely as you can at an area half the size of a piece of binder paper. Write and sketch what you see. Write down 5 questions about what you see.

Group Activities

As a class, discuss what they saw and learned.

- What was most interesting?
- What was most surprising?
- What would they like to see again, or what did they miss?
- What do intertidal organisms do at night?
- Be sure to include discussion about threats to the marine environment and how they as individuals and as a class can help protect the environment.

Before leaving the beach, have students do a "beach patrol" to pick up any litter. Recycle whatever is possible. Leave the area cleaner than you found it!

Role play

While it is still fresh in their minds, have students act out such tide pool events as: (teacher can describe scenario)

- Waves crashing on a rock
- An oystercatcher looking for food
- A hermit crab moving into a new shell
- An anemone capturing a fish
- A snail feeding on algae
- A sculpin darting for cover at the approach of a gull
- A sea star prying open and feeding on a mussel
- A water molecule evaporating and going through the whole water cycle
- A barnacle feeding with its legs at high tide and closing up at low tide
- A crab walking sideways, defending itself with its claws
- An organism reacting to the tide going out and then coming in

Reference (for role playing)

Snively: *Once Upon a Seashore*, p.211-232

Post-Trip Lessons and Activities

Too many field trips are isolated experiences. It is important that students are able to relate what they learned on the trip to their everyday lives and future activities and choices.

Hands-On Activities

Adopt-A-Beach

After visiting the coast, students (and parents) may be willing to "adopt" a beach, park, or section of roadside. Adopting a beach essentially means committing to periodically visiting the area and cleaning it up. You might consider having a school adopt a beach, with different classes doing the cleanup each month.

This can be done informally, or through the state's Adopt-A-Beach program. Contact the local park officials, and go to the Coastal Commission's web site (below) and click on "Programs and Contests." This is also the site for information on the Coastal Cleanup Day in September.

< **www.coastal.ca.gov** >

<u>Standard(s)</u>

Grade 3 - S.S. 3.4.2; Math Number Sense 1.1; Writing 2.3
Grade 4 - Math 3.1
Grade 5 - Science: Investigation 6.g
Grade 6 - Science Resources 6.b, 6.c

<u>References</u> (See the "Resources" section at the back of this Guide)

Armstrong: *Sea Searcher's Handbook*, p. 189-199
Brown-Babcock: *Save Our Seas*, the whole thing
California Coastal Commission, especially Adopt-A-Beach program
Snively: *Once Upon a Seashore*, p. 266-296
Snively: *Beach Explorations*, p. 73-74

Oil on the Water!

Activity Summary

Students use vegetable oil to model an oil spill; then they use various materials in an attempt to clean it up.

Note: This activity is closely related to the following two activities, "Like Water Off a Duck?" and "You Can Help!"

Introduction

Oil can enter coastal ecosystems from many sources. Huge spills such as the *Exxon Valdez* receive headline coverage, but thousands of small spills add oil to the ocean every day. These spills come from oil platforms, pipelines, oil tankers, and cargo, cruise, and fishing ships and boats. Some areas of California's coast have always experienced natural seepage. California Indians even used globs of the tarry oil that washed up on the coast for sealing their canoes.

Another source of oil pollution is storm drains that bring oil from the streets. Some people change their engine oil and dump it into the gutter, which adds more oil to the storm drains. Storm drains bring not only oil, but also engine coolants, insecticides and fertilizers from lawns and gardens, soap from cleaning cars, litter, and anything else that falls into the gutter.

Oil is harmful to marine organisms for many reasons. Oil, especially crude oil, is a mixture of chemicals, many of which are toxic. Crude oil is often very sticky and can cover organisms with a thick, tar-like coating, smothering them, preventing them from moving, coating their food sources, sticking shells together, or simply poisoning them. Warm blooded animals such as birds, seals, and otters depend on their feathers and fur to provide insulation from cold ocean waters. Oil destroys the insulating value of their fur or feathers. The barbules on feathers of marine birds are so tightly interwoven that water can't penetrate them. Mammals have some natural oils, but are harmed when they try to clean themselves and ingest the toxic chemicals. Chemicals that remove spilled oil also remove this oil from the animals' fur, and the cleaning process can damage feathers.

Since so much of the oil that we use goes to energy generation and transportation, anything that we can do to reduce energy and private auto use will reduce the demand to drill for, transport, and refine more oil.

Grouping

Groups of 2-4 students

Time

30-60 minutes

Oil on the Water! (continued)

Anticipated Outcomes

Students will understand that oil is harmful to marine organisms for many reasons.
Students will be able to identify several sources of oil pollution.
Students will understand that saving energy helps reduce oil pollution.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2, 3.4.2; Writing 2.2; Life Science 3.a-d, Investigation 5.a
Grade 4 - S.S. 4.2.1; Life Science 2.b, 3.a-c, Investigation 6.a-f
Grade 5 - S.S. 5.1.1; Life Science 2.a, Investigation 6.b-i
Grade 6 - S.S. 6.1.2; Earth Science 1.f, 2.c, Resources 6.a-c, Investigation 7.a-7.h

Materials

For each group:
- ❒ 1 shallow pan (aluminum baking?) Save to reuse next year
- ❒ Water
- ❒ Vegetable oil. The amount depends on size of pan. (Some teachers use motor oil, or used motor oil. This presents the problem of what to do with the oil afterwards. **The use of motor oil is NOT RECOMMENDED!**)
- ❒ Cleanup materials: paper towels, cotton balls, soap (liquid, solid, powdered?), sponges, pieces of cloth etc., mineral oil
- ❒ Rags or paper towels and soap for cleanup
- ❒ Newspapers to put under the pans
- ❒ Optional: One or more contour (and maybe down) feathers from a duck or other aquatic bird (not an old weathered feather found on the beach)
- ❒ Optional: A piece of long fake fur, approx 3" x 3"

Teacher Preparation **(Try this experiment yourself before doing it with students!)**
- ❒ Obtain the materials and try the experiment yourself.
- ❒ Either set up experiment stations or plan how to have the students get the materials.
- ❒ Plan how to clean up.

Procedure

1. Pour 2-3" of water in a pan to simulate a body of water such as a lake, tide pool, or ocean.
2. Students simulate an oil spill by pouring some vegetable oil into the “ocean.”
3. Optional: Immerse feathers and fake fur to simulate animals caught in the oil spill.
4. Discuss with students how they might clean up the oil spill.
5. Have them predict, in writing, what materials will be most effective.

Oil on the Water! (continued)

6. Have the students attempt to clean up the oil spill with various materials, recording how effective each is.
7. Have students clean up.

Discussion

1. See above.
2. How difficult would it be to try to clean up a coastal oil spill with something like cotton balls or paper towels? How would you clean a 500 pound seal or sharp beaked bird?
3. How might an oil spill affect coastal organisms?
4. How can oil spills be prevented? (Be sure to discuss sources like storm drains and boats.)
5. Some people have used hot water under pressure to clean oil-covered rocks. What do you think that would do to plants and animals? What about mineral oil or detergents?

Assessment

- Can students describe various sources of oil pollution?
- Can students describe problems caused by oil pollution?
- Can students suggest ways that they can help prevent oil pollution?

References

International Bird Rescue Research Center
Roa: *Environmental Science Activities Kit,* p. 89-98

Like Water off a Duck's Back?

Activity Summary

Students see that an aquatic bird feather sheds water, then apply oil to it and remove the oil, after which the feather doesn't shed water as well.

Note: This activity is closely related to the previous activity (Oil on the Water!) and the following activity (You Can Help!).

Introduction

Oil can enter coastal ecosystems from many sources. Huge spills such as the *Exxon Valdez* receive headline coverage, but thousands of small spills add oil to the ocean every day. These spills come from oil platforms, pipelines, oil tankers, and cargo, cruise, and pleasure ships and boats. Some areas of California's coast have always experienced natural seepage.

Another source of oil pollution is storm drains that bring oil from the streets. Some people change their engine oil and dump it into the gutter, which adds more oil to the storm drains. Storm drains bring not only oil, but also engine coolants, insecticides and fertilizers from lawns and gardens, soap from cleaning cars, litter, and anything else that falls into the gutter.

Oil is harmful to marine organisms for many reasons. Oil, especially crude oil, is a mixture of chemicals, many of which are toxic. Crude oil is often very sticky and can cover organisms with a thick, tar-like coating, smothering them, preventing them from moving, coating their food sources, sticking shells together, or simply poisoning them. Warm blooded animals such as birds, seals, and otters depend on their feathers and fur to provide insulation from cold ocean waters. Oil destroys the insulating value of their fur or feathers. The barbules on feathers of marine birds are so tightly interwoven that water can't penetrate them. Mammals have some natural oils, but are harmed when they try to clean themselves and ingest the toxic chemicals. Chemicals that remove spilled oil also remove this oil from the animals' fur, and the cleaning process can damage feathers.

Since so much of the oil that we use goes to energy generation and transportation, anything that we can do to reduce energy and private auto use will reduce the demand to drill for, transport, and refine more oil.

Grouping

Groups of 2-4 students

Time

20-45 minutes

Like Water Off a Duck's Back? (continued)

Anticipated Outcomes

Students will understand that oil is harmful to marine organisms for many reasons.
Students will be able to identify several sources of oil pollution.
Students will understand how oil affects marine birds.
Students will undertake action to try to reduce oil pollution.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2, 3.4.2; Writing 2.2; Life Science 3.a-d, Investigation 5.a
Grade 4 - S.S. 4.2.1; Life Science 2.b, 3.a-c, Investigation 6.a-f
Grade 5 - S.S. 5.1.1; Life Science 2.a, Investigation 6.b-i
Grade 6 - S.S. 6.1.2; Earth Science 1.f, 2.c, Resources 6.a-c, Investigation 7.a-7.h

Materials

For each group:

- ❒ Magnifiers or microscope
- ❒ Droppers (plastic pipettes)
- ❒ Shallow pan such as an aluminum pie tin or baking pan
- ❒ Vegetable oil…amount depends on size of pan
- ❒ Soap…liquid or powdered
- ❒ One or more contour (and maybe down) feathers from a duck or goose
- ❒ Rags or paper towels for cleanup
- ❒ Newspapers to put under the pans

Teacher Preparation (Try this experiment yourself before doing it with students!)

- ❒ Obtain feathers from ducks or other aquatic birds. The feathers should be fairly fresh, and in good condition, rather than feathers that have washed up on the beach. This is because new feathers will have intact barbules, and oils that help repel water. You might look in the yellow pages under "Birds" or contact a local 4-H or FFA group, duck hunter, or taxidermist. You might be able to contact someone who raises ducks through a feed store. When at the beach, watch for fresh dead birds.

Procedure

1. Students first use the magnifier to examine their clean, dry feather describing it in as much detail as possible, possibly sketching details. Have them look for the interlocking barbules.
2. Students then use a dropper to drop a small amount of water on the feather. They describe what happens. (If the feather is in good shape, the water should bead up and roll off.)

Barbules

Like Water Off a Duck's Back? (continued)

3. They then pour some oil onto the feather and massage it in. (This simulates a feather from a bird that got caught in an oil spill. Point out that cooking oil is not as sticky as crude oil.)
4. Students then use soap and other materials to remove the oil, then they rinse the cleaned feather in water. (Usually the barbules will have been messed up and the natural oil lost.)
5. After drying the feather, students examine and describe the feather again, and again test it for water repellency.

<u>Discussion</u>

1. How does having water-repellant feathers help aquatic birds survive? (Even when in the water, the skin remains dry, with trapped air providing insulation from cold water.)
2. What would probably happen to a bird that had been cleaned by rubbing it with soap if it were immediately returned to the ocean?
3. How can they, the students, reduce oil entering the ocean?

<u>Assessment</u>

- Can students tell how oil pollution affects aquatic birds?
- Can students suggest ways that they can help prevent oil pollution?

<u>References</u>

Roa: *Environmental Science Activities Kit*, p. 89-98
International Bird Rescue and Research Center

You Can Help!

Activity Summary

Students make posters, write letters, or produce flyers to encourage people to reduce oil and other types of ocean pollution.

Note: This activity is closely related to the preceding two activities, "Oil on the Water!" and "Like Water off a Duck?"

Introduction

Oil can enter coastal ecosystems from many sources. Huge spills such as the *Exxon Valdez* receive headline coverage, but thousands of small spills add oil to the ocean every day. These spills come from oil platforms, pipelines, oil tankers, and cargo, cruise, and pleasure ships and boats. Some areas of California's coast have always experienced natural seepage. California Indians even used globs of the tarry oil that washed up on the coast for sealing their canoes.

Another source of oil pollution is storm drains that bring oil from the streets. Some people change their engine oil and dump it into the gutter, which adds more oil to the storm drains. Storm drains bring not only oil, but also engine coolants, insecticides and fertilizers from lawns and gardens, soap from cleaning cars, litter, and anything else that falls into the gutter.

Oil is harmful to marine organisms for many reasons. Oil, especially crude oil, is a mixture of chemicals, many of which are toxic. Crude oil is often very sticky and can cover organisms with a thick, tar-like coating, smothering them, preventing them from moving, coating their food sources, sticking shells together, or simply poisoning them. Warm blooded animals such as birds, seals, and otters depend on their feathers and fur to provide insulation from cold ocean waters. Oil destroys the insulating value of their fur or feathers. The barbules on feathers of marine birds are so tightly interwoven that water can't penetrate them. Mammals have some natural oils, but are harmed when they try to clean themselves and ingest the toxic chemicals. Chemicals that remove spilled oil also remove this oil from the animals' fur, and the cleaning process can damage feathers.

Since so much of the oil that we use goes to energy generation and transportation, anything that we can do to reduce energy and private auto use will reduce the demand to drill for, transport, and refine more oil.

Grouping

Individuals or groups of 2-4 students

Time

30-60 minutes

You Can Help! (continued)

Anticipated Outcomes

Students will understand that oil is harmful to marine organisms for many reasons.
Students will be able to identify several sources of oil pollution.
Students will understand how oil affects marine birds.
Students will undertake action to try to reduce oil pollution.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2, 3.4.2; Writing 2.2; Life Science 3.a-d, Investigation 5.a
Grade 4 - S.S. 4.2.1; Life Science 2.b, 3.a-c, Investigation 6.a-f
Grade 5 - S.S. 5.1.1; Life Science 2.a, Investigation 6.b-i
Grade 6 - S.S. 6.1.2; Earth Science 1.f, 2.c, Resources 6.a-c, Investigation 7.a-7.h

Materials

❒ Art supplies

Teacher Preparation

❒ If you are having the students write letters to the editor, obtain the address for the paper.
❒ To obtain a storm drain stenciling kit or to find out about any local stenciling projects, contact:
Your local public works department (They may be willing to obtain the kit.)
Ocean Conservancy at: < **www.oceanconservancy.org** > (click on “programs”)
❒ Contact the California Coastal Commission for many ways to get students involved: < **www.coastal.ca.gov** >

Procedure

There are a number of things that students can do to reduce oil spillage. Among them are:

1. Anything that reduces energy use also reduces oil use. Have students find out ways to conserve energy.
2. Have students keep track of the kinds of things that they observe in rain gutters along streets, including evidence of oil or soap. They can then write an article or letter to the editor for a local newspaper.
3. Students can write articles for the school newspaper.
4. Students can make a flyer to tell people about the problem of oil pollution and what people can do to reduce it. They can distribute the flyer to parents and at local stores.
5. Students can create an insert to be added to water or sewer bills to inform people about the problems associated with oil runoff.
6. Students can make posters to put up at stores that sell motor oil.
7. Students can stencil signs on sidewalks above storm drains. The signs can say something like:

You Can Help! (continued)

Discussion

1. How might oil or other chemicals from storm drains affect coastal organisms?
2. How can we reduce pollution from storm drains?

PLEASE ... NO OIL OR OTHER CHEMICALS or **DRAINS TO SEA ... PLEASE ... NO OIL!** or **NO DUMPING ... DRAINS TO BAY**

Assessment

- Can students describe various sources of oil pollution?
- Can students describe problems caused by oil pollution?
- Can students suggest ways that they can help prevent oil pollution?

References (See the "Resources" section at the back of this *Guide*.)
Brown-Babcock: *Save Our Seas*, pp. 16-17, 56-59, 66-70
Roa: *Environmental Science Activities Kit*, p. 89-98

Other Activities

Letter Writing

- After the field trip, every student should write a letter of appreciation. Letters should go to parent volunteers and helpers and to park personnel or volunteer docents. (Be sure to get names before or during the trip.)
- Students can write letters to organizations that are working to protect and improve the environment. See the resources in Appendix C, pages 155-157.
- Students can write letters to newspapers. They might express concern about environmental problems, suggest ways to protect and improve the environment, or express their appreciation for those who have helped.

Some suggestions for letter writing:

1. Have the students use the complete writing process that you use as part of your language arts program: brainstorming, mind mapping, writing and editing drafts, etc.
2. Check spelling, especially of names.
3. Keep letters brief. If it's a letter to a legislator, it probably won't get read by the legislator himself or herself, but will be added to a tally.
4. Be sure that the student makes a point, rather than just complaining. What do they want done?
5. Look for opportunities to write positive letters praising individuals or groups for doing good things!
6. Be sure to request a response and supply a name and address, perhaps c/o the teacher at the school. (Students should **not** give their home addresses.)

More suggestions for letter writing can be found in:
Brown-Babcock: *Save Our Seas,* p. 97
Davenport: *Waves, Wetlands, and Watersheds,* p. 149
Roa: *Environmental Science Activities Kit,* p. 323-327

Standard(s)

Grade 3 - S.S. 3.4.2; Writing 2.2, 2.3; Science Investigation 5.b
Grade 4 - none
Grade 5 - Listening and Speaking 1.2; Science Investigation 6.h, 6.i
Grade 6 - none

Debates

After discussing various environmental issues and threats, students can debate such topics as:

- Should people be allowed to buy land and build where there are now tide pools or beach access?
- Should tide pools be given a 5 year recovery period in which nobody is allowed to visit them except scientists?
- Should people be prohibited from gathering mussels, abalone, and sea urchins for food?
- Should people be allowed to take home rocks, shells or organisms that they find dead?
- Should all whale hunting be banned?
- Should fishermen be allowed to shoot sea lions and seals that compete with them for salmon?
- Should there be a 5 year moratorium on abalone fishing?
- Should logging companies have to pay for damage caused by silt from their logging operations far from the coast?

Be careful not to let the debates get personal.

Standard(s)

Grade 3 - S.S. 3.4.2; Writing 2.2; Science Investigation 5.b, 5.c
Grade 4 - Science Investigation 6.a-c, 6.e
Grade 5 - Listening and Speaking 1.1, 1.2; Science Investigation 6.h
Grade 6 - Science Investigation 7.d, 7.g, 7.h

Reports

Students can write reports or give oral reports on various organisms, physical factors, or environmental issues. Reports can be illustrated with student drawn pictures or images from the Internet.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2, 3.2.2, 3.4.2; Writing 2.2; All Science topics, including experiments, offer potential report topics.
Grade 4 - S.S. 4.2.1, 4.2.1; All Science topics, including experiments, offer potential report topics.
Grade 5 - S.S. 5.1.1; Writing 2.3; All Science topics, including experiments, offer potential report topics.
Grade 6 - S.S. 6.1.1, 6.1.2; Writing 2.3; All Science topics, including experiments, offer potential report topics.

Storytelling

California Indians, like all people, wondered about the causes of natural phenomena such as moon phases, tides, storms, and the creation of the earth, life on earth, and humans.

The following books may be useful in teaching about California Indian stories:

Caduto, Michael and Joseph Bruchac. *Keepers of the Earth*. Golden, CO: Fulcrum Publishing, 1988.

Clark, Ella. *Indian Legends of the Pacific Northwest*. Berkeley: University of California Press, 1953.

Gifford, Edward et al. *California Indian Nights*. Lincoln, Nebraska: University of Nebraska Press, 1990.

Kroeber, Theodora. *The Inland Whale - Nine Stories Retold from California Indian Legends*. Berkeley: University of California Press, 1959.

Lake-Thom, Bobby. *Spirits of the Earth*. NY: Penguin Books, 1997.

Margolin, Malcom, ed. *The Way We Lived - California Indian Reminiscences, Stories, and Songs*. Berkeley: Heyday Books, 1993.

Monroe, Jean Guard and Ray Williamson. *They Dance in the Sky*. Boston: Houghton Mifflin, 1988.

Sarris, Greg. *Keeping Slug Woman Alive*. Berkeley: University of California Press, 1993.

Have the students make up and illustrate their own stories. Some topic ideas:

- How/why the barnacle got its plates
- Why the clam lives in the mud
- Why the gull squawks so much
- How the oystercatcher got its long legs
- How the crab got its pinchers
- How the sea star got the ability to regenerate lost legs
- Why some ochre stars are purple and some are orange
- Why we have tides
- Where waves come from
- Why hermit crabs don’t have their own shells
- How the ocean became salty

Students can ask their own questions and make up their own topics.

<u>Standard(s)</u>

Grade 3 - S.S. 3.1-3.4; Writing 2.2; All Physical, Earth and Life Science phenomena offer potential as bases for myths.

Grade 4 - S.S. 4.2.1, 4.2.2; All Physical, Earth and Life Science phenomena offer potential as bases for myths.

Grade 5 - S.S. 5.1.1; Writing 2.3; All Physical, Earth and Life Science phenomena offer potential as bases for myths.

Grade 6 - S.S. 6.1.1, 6.1.2; Writing 2.3; All Physical, Earth and Life Science phenomena offer potential as bases for myths.

Gotta Love It!

Students can produce written, drawn, or acted out advertisements:

- for an organism of their choice. The ads would tell something interesting about the organism and why it is important.
- to encourage people to protect the environment or to take action to improve it.
- to teach about an organism or phenomenon such as tides.

Standard(s)

Grade 3 - S.S. 3.4.2; Writing 2.2; All Science topics, especially organisms, are potential topics for such projects
Grade 4 - S.S. 4.2.1, 4.2.2; All Science topics, especially organisms, are potential topics for such projects
Grade 5 - Writing 2.3; All Science topics, especially organisms, are potential topics for such projects
Grade 6 - Writing 2.3; All Science topics, especially organisms, are potential topics for such projects

Reference

Roa: *Environmental Science Activities Kit*, p. 70-85

Who am I?

After studying tide pool organisms, play a game of 20 Questions by having students draw names of organisms from a jar. Classmates ask "yes or no" questions to determine the type of organism.

Variation: A student has the name of an organism taped to her back and she asks questions of others to try to figure out who she "is." The illustrations of organisms in this *Guide*, with the accompanying information, could be used for this.

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a, 3.b, 3.c
Grade 4 - Life Science 2.b, 2.c, 3.a, 3.b, 3.c
Grade 5 - Life Sciences 2.a, Investigation 6.a
Grade 6 - Life Science 5.c, 5.d, 5.e

References (See the "Resources" section at the back of this Guide)

Armstrong: *Sea Searcher's Handbook* - Includes drawings and descriptions of many organisms
Snively: *Once Upon a Seashore*, p. 47-77

Bulletin Boards

Students can produce a bulletin board illustrating the intertidal zones and the organisms found in each zone. Consider using folded paper, cardboard, or other materials to make it 3-dimensional. The display might represent a rocky coast, sandy shore, kelp "forest," or wharf piling.

Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2, 3.2.2, 3.4.2; Writing 2.2; All Science topics, including experiments, offer potential bulletin board topics
Grade 4 - S.S. 4.2.1, 4.2.2; All Science topics, including experiments, offer potential bulletin board topics
Grade 5 - S.S. 5.1.1; All Science topics, including experiments, offer potential bulletin board topics
Grade 6 - S.S. 6.1.1, 6.1.2; All Science topics, including experiments, offer potential bulletin board topics

Skits

Students can create skits or plays in which they act out such events as:

- a sea star feeding on a mussel
- a sea anemone capturing a crab
- an abalone or snail feeding on algae
- a barnacle using its legs for feeding
- a porpoise getting caught in a fishing net
- a bird diving into an oil spill
- a hermit crab moving into an empty shell
- organisms living under a rock or algal mass when it is lifted up by a curious student
- a student meeting someone who is taking organisms from a tide pool

Standard(s)

Grade 3 - S.S. 3.1.2, 3.2.2, 3.4.2; Writing 2.2; Life Science 3.a-d
Grade 4 - S.S. 4.2.1; Life Science 2.a-c, 3.a-c
Grade 5 - S.S. 5.1.1; Listening and Speaking 1.2; Life Sciences 2.a-g, Earth Sciences 3.a-c
Grade 6 - S.S. 6.1.1, 6.1.2; Earth Science 2.c, 2.d, Ecology 5.a-5.e

References (See the "Resources" section at the back of this guide)
Armstrong: *Sea Searcher's Handbook*, several activities
Snively: *Beach Explorations*, several activities
Snively: *Once Upon a Seashore*, several activities

Models

Students can make models of tide pool organisms. Have them write a paragraph or a page about the organism and its unique adaptations.

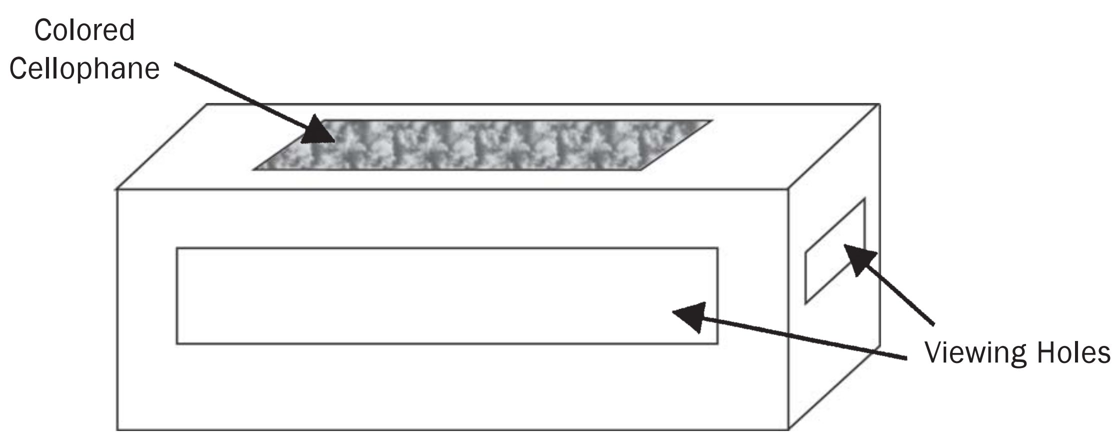
Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2; Math Measurement 1.1; Writing 2.2; Life Science 3.a, 3.b,
Grade 4 - S.S. 4.2.1, 4.2.2; Life Science 2.b, 3.a
Grade 5 - S.S. 5.1.1; Math Measurement 1.3; Writing 2.3; Physical Sciences 1.b, Life Sciences 2.a
Grade 6 - S.S. 6.1.1, 6.1.2; Earth Science 1.f, 2.c, 2.d, Ecology 5.a-5.e, Resources 6.a-c

Dioramas

Students can make dioramas of tide pools.

- Consider having teams of students responsible for large dioramas of the zones.
- Display the dioramas in the school or public library.
- A very interesting diorama can be made with a box in which a hole is cut in the cover. The hole is covered with plastic wrap or clear or colored cellophane (blue, green, or aqua), which provides an interest-ing lighting effect. The diorama is viewed through a hole in the side. The viewing hole can be covered with clear plastic or cellophane



Standard(s)

Grade 3 - S.S. 3.1.1, 3.1.2; Math Measurement 1.1; Writing 2.2; Life Science 3.a, 3.b,
Grade 4 - S.S. 4.2.1, 4.2.2; Life Science 2.b, 3.a
Grade 5 - S.S. 5.1.1; Math Measurement 1.3; Writing 2.3; Physical Sciences 1.b, Life Sciences 2.a
Grade 6 - S.S. 6.1.1, 6.1.2; Earth Science 1.f, 2.c, 2.d, Ecology 5.a-5.e, Resources 6.a-c

Create a Critter

Students can design and either draw or build models of animals with adaptations to live in tide pools (or wetlands, the deep ocean, on a sandy beach, kelp forest, or?).

The organisms should have adaptations for:

- obtaining oxygen
- obtaining food…What does it eat?
- dealing with or avoiding predators…What preys on it?
- getting rid of waste
- finding a mate
- dealing with crashing waves (or other environmental factors)

Have the students write about the adaptations and explain them to you or to the class.

Have the students give their organism a scientific name that describes it (possibly using Latin word roots). To what other organisms is it related?

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a-d
Grade 4 - Reading 1.3, 1.4; Life Science 2.a-c, 3.a-c
Grade 5 - Life Sciences 2.a
Grade 6 - Life Science 5.c-e

Reference (See the “Resources” section at the back of this Guide)
Armstrong: *Sea Searcher’s Handbook*, p. 80, 97

Sea Songs

Students can make up songs about marine organisms or the coast. A couple of starters:

- The waves on the coast go crash, crash, crash…
  (to "The Wheels on the Bus go Round and Round)
- Old MacKerricher had a coast, e-i, e-i, oh!...
  (to Old MacDonald Had a Farm)
- The itsy bitsy crab crawled up the tidal pool…
  (to Itsy Bitsy Spider)
- Crawl, crawl, crawl around, in the tidal pool…
  (to Row, Row, Row Your Boat)

Standard(s)

Grade 3 - Writing 2.2; Life Science 3.a-d
Grade 4 - Life Science 2.a-c, 3.a-d
Grade 5 - Life Sciences 2.a-g
Grade 6 - Writing 2.3; any other Science topics

Reference (See the "Resources" section at the back of this *Guide*)
Armstrong: *Sea Searcher's Handbook*, p. 49, 197

See Sea Art

Students will often want to bring shells or rocks home from the beach. Before going on the field trip, discuss why they shouldn't do so. You may be able to arrange for seafood restaurants to save oyster shells for you. Obtain one oyster shell for each student.

- Students can paint ocean scenes, plants, or animals on the smooth inside surface.
- If the shells are large, they can use the shell as a base for a clay seashore scene/diorama.
- Shells can be used as a mold/base for making candles.
- Challenge students to find the matching top and bottom halves of the shells.
- Have them examine the shells carefully for the muscle scar where the muscle was attached, for tube worm cases or barnacles on the outside, or any other details that they might notice.

Students enjoy making fish prints, but the benefits of using a food fish for making prints must be considered.

- The Dick Blick art supply company (< **www.dickblick.com** >) and Acorn Naturalists (< **www.acornnaturalists.com** >) have rubber replicas of several kinds of fish that can be substituted for real fish when making fish prints.

Sand candles can be made either at the beach or at school. They can be decorated with bits of driftwood or shells collected from beaches **other than state or national parks.**

Mobiles can be made from driftwood and shells collected from beaches **other than state or national parks.**

Cover Art: The cover illustration of this Guide can be colored by students. They can identify/label the various organisms seen in the illustration.

Standard(s)

Grade 3 - S.S. 3.4.2; Measurement 1.1; Writing 2.2; Life Science 3.a, 3.b
Grade 4 - Life Science 3.a
Grade 5 - Investigation 6.a
Grade 6 - Science Resources 6.c