HERMIT CRAB MUSICAL CHAIRS

Time: 30 minutes

Grade Level: K - 3rd Grade

Group Size: Variable

Vocabulary: Exoskeleton

SCIENCE STANDARDS

K – 2. Different types of plants and animals inhabit the earth. 2 a. Students know how to observe and describe similarities and differences in the appearance and behavior of plants and animals.

1st – 2. Plants and animals meet their needs in different ways. 2 a. Students know different plants and animals inhabit different kinds of environments and have external features that help them thrive in different kinds of places. 2 c. Students know animals eat plants or other animals for food and may also use plants or even other animals for shelter and nesting.

3rd – 2. Adaptations in physical structure or behavior may improve an organism's chance for survival. 2 b. Students know examples of diverse life forms in different environments, such as ocean, deserts, tundra, forests, grasslands, and wetlands.

OVERVIEW

Students will cut out and color hermit crab pictures that will show them the adaptations of the hermit crab. They will learn that hermit crabs use another animal's shell for shelter. They can then use the cutouts to play a game that illustrates the importance of protecting the marine environment.

TEACHER BACKGROUND

Where do seashells come from? Sea Snails (and bivalves) make seashells. Sea Snails secrete calcium carbonate and build their shells as they grow older. When you see an empty seashell it means the original inhabiting snail has died. Possible reasons for death include predatory animals (sea stars, moon snails), pollution, or disease.

How do hermit crabs get their shells? Hermit crabs have an exoskeleton (outer shell) that is not as hard as most crabs. For added protection they have to find an "uninhabited" snail shell. This shell does not grow with them, so, as the seashell becomes too small, the hermit crab has to find a new one. The hermit crab's body shape is adapted to fit into the inside spiral of a seashell and its back legs are small for holding onto the shell.

How do people impact hermit crabs? People like to collect shells when they go to the tidepools. If only they knew that empty shells are really future hermit crab homes! Each shell that is collected is one less hermit crab home. If the hermit crab cannot find a large enough home, it may have to go around without one and will become easy prey for tidepool predators (like other seastars and octopus).

MATERIALS

- Hermit Crab worksheet
- Crayons and scissors

- Music
- Optional: sea shells, either natural or replicas

ADVANCED PREPARATION

- Copy worksheets, one per student
- Gather materials

PROCEDURES

__Engage__: Show the students a picture of a shell or, if available, pass around a real seashell. Ask the students what animal makes seashells and have them describe how a shell looks and feels.

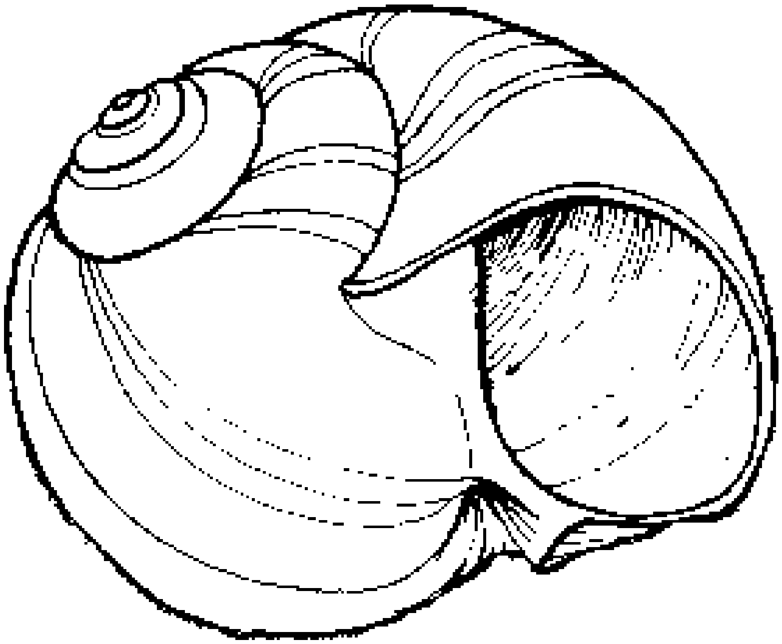
1. Hand out the worksheet and supplies and have them color and cut out their hermit crab. Young students may need help in cutting the slit in the shell.

__Challenge__: Challenge the students to use the cut out pictures to discover how and why hermit crabs use a seashell and how its body is shaped (adapted) to it.

2. Have the students put the hermit crab cut out in the shell slit. Make sure they understand that this represents the hermit crab going into the snail shell.
3. Discussion: Use the paper hermit crabs to discuss hermit crab adaptations. Why does it use a snail shell for shelter? Why isn't it shaped like other crabs? Why does the hermit crab have a 'curved hot dog' shape behind? (To fit into the seashell whirl.)
4. Ask the students what a hermit crab needs to do when it gets too large for its shell. Hermit crabs must find a larger shell. What would happen if it could not find a larger shell? Why might a tidepool hermit crab have a problem finding a new shell? (People take them.) The game will show the effect this might have on the hermit crabs and how students can help.
5. Set up the game:
   This game plays like musical chairs. Students have their own shell and hermit crab picture. The shell picture replaces the chair. Arrange the students in 1 or 2 lines or randomly around the room. Start the game by having the hermit crabs say "*Oh, I am growing so big and my shell feels so small. I am going to have to find a new one.*" Have students put their shell pictures down. Start the music or say "Start" and have the students walk around the room. Pretend you are a person at the tidepools and say, "Look at these beautiful shells. I think I will *take some home*." Remove 1 or 2 shell pictures. Stop the music (or say stop). Each student must find a shell to live in. Students who do not find one are out of the game. Continue until only one student is left.

__Conclusion / Discussion__:

Ask students if it were a good idea for people to have collected empty shells. What happens to hermit crabs if they cannot find a shell? Remind students that next time they go to the tidepools they need to leave the shells, no matter how pretty they are.



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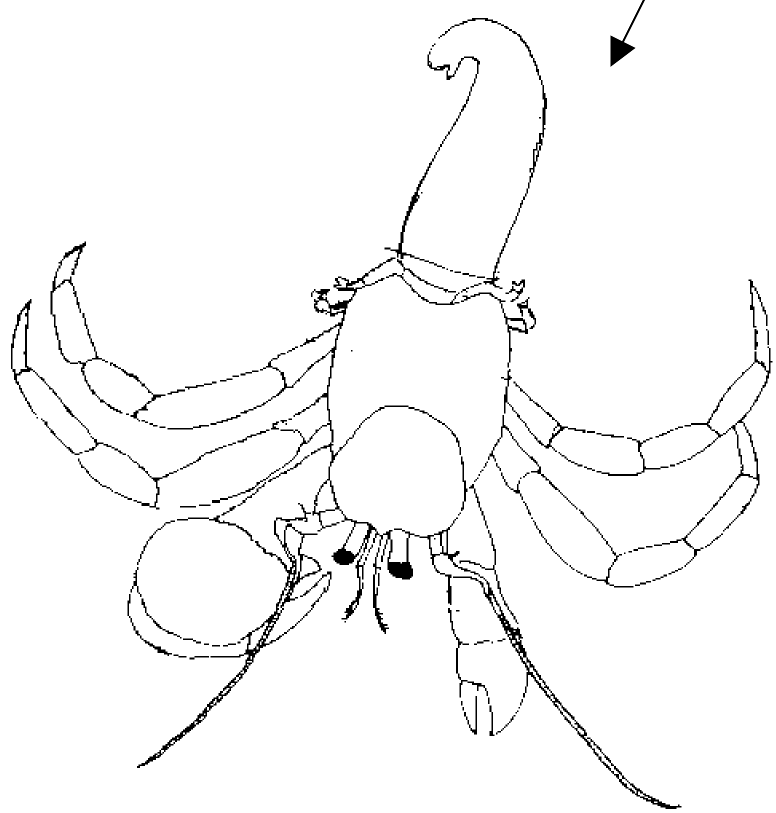


SHELL PREFERENCE OF HERMIT CRABS

Time: 20 minutes
Grade Level: 1st-2nd grade
Group Size: 4/group
Vocabulary: Quadrat

STANDARDS

1st – 2. Plants and animals meet their needs in different ways. c. Students know animals eat plants or other animals for food and may also use plants or even other animals for shelter and nesting. 4. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. b. Record observations and data with pictures, numbers, or written statements.

2nd – 4. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. e. Construct bar graphs to record data, using appropriately labeled axes.

OVERVIEW

Students will conduct a simple scientific study to determine the shell preference of hermit crabs in their local tidepools. They will use observation skills to identify the various shell types and use math skills to tally and create graphs of their results.

BACKGROUND

Hermit crabs have an exoskeleton that is not as hard as that of most crabs. For added protection, they must find an uninhabited shell. These shells generally come from a snail that has died due to predation, pollution, disease, or old age. Thus, this shell does not grow with the hermit crab and they are periodically forced seek out new, more suitable homes. Shell selection plays an important role throughout the hermit crab's life because it will ultimately affect the hermit crab's growth, clutch size, and survival. When empty shells are abundant, this selection process can be complex, involving factors such as shell weight, shell volume, and shell size. However, when they are in limited supply, crabs will settle for shells that are damaged or ones that have come from a less desirable species of snail. This limitation is usually what creates the diversity of shells we see the hermit crabs wearing in our tidepools.

MATERIALS

- Data Sheet
- Poster board or other sturdy (preferably water resistant) material, stapler or glue
- Pencil

ADVANCED PREPARATION

- Carefully review the data sheets.
- Make copies of the data sheets for each group of students, along with the pictures of the various shell types.

- Make quadrats using poster board or other sturdy (preferably water resistant) material. To make a simple quadrat, cut out four equally sized strips of poster board, each 1" wide by 13" long. Staple or glue the corners of the strips together to form a square. The interior edges of the quadrat should measure 12" x 12".
- Determine an appropriate and safe tidepool area where the students can conduct the activity.

PROCEDURE

Engage: Ask the students where hermit crabs get their shells. What other animals also have shells? What might a hermit crab look for in choosing a shell?

Explain to the students that they will observe the hermit crabs present in their tidepools and see what kinds of shells they are wearing.

Challenge: Place a quadrat over an easily accessible tidepool containing several hermit crabs. Challenge each group of students to identify and count the different types of shells they see on the hermit crabs within their quadrat.

1. Using the Shell ID sheet, students will identify the types of shell the hermit crabs. They will write these names on the data sheet.
2. Students will record their counts by making a tally of each shell type on the data sheet.
3. They will then use the total number of each shell found to create a bar graph of the results.

Discussion: Compare the results by looking at the bar graph.

- Which shell was the most popular?
- Why do you think hermit crabs choose this shell type over others?

Snail Shell Preference of Hermit Crabs

Data Sheet

Date: ______________________________

Time: ______________________________

Tide: ______________________________

Collection Site: ______________________

General Observations: ____
____
____
____

	Shell #1	Shell #2	Shell #3	Shell #4	Shell #5	Shell #6
Shell Name						
Tally of Hermit Crabs						
Total						

Create a Bar Graph of Shell Preference

Nu

be 12
11
10
9
r 8
7
6
5
4
3
2
1

Shell #1	Shell #2	Shell #3	Shell #4	Shell #5	Shell #6

TIDEPOOL ANIMAL ROLE PLAY

Time: 30 minutes
Grade Level: K - 3rd Grade
Group Size: Variable
Vocabulary: Tide, intertidal habitat, tidepool

SCIENCE STANDARDS

K – 2. Different types of plants and animals inhabit the earth. 2 a. Students know how to observe and describe similarities and differences in the appearance and behavior of plants and animals.
1st – 2. Plants and animals meet their needs in different ways. 2 a. Students know different plants and animals inhabit different kinds of environments and have external features that help them thrive in different kinds of places.
3rd – 2. Adaptations in physical structure or behavior may improve an organism's chance for survival. 2 b. Students know examples of diverse life forms in different environments, such as ocean, deserts, tundra, forests, grasslands, and wetlands.

OVERVIEW

The students will work in groups to role-play different intertidal animals. This will show how animals have unique adaptations to help them survive in the intertidal habitat. They will look at pictures of each animal and watch as the animal's behavior is demonstrated. They will then act out the behavior of the animal during high tide and during low tide and explain why this behavior is needed.

TEACHER BACKGROUND

It is the gravitational pull of the earth, moon, and sun upon each other that causes our tides, with the moon having the greatest effect. In California we have four tidal changes each day: two high and two low, that differ in height and time each day. The lower the tide, the longer the intertidal animals are out of water.

The intertidal habitat is the area along the shore that falls between the high and low tide lines. Tidepools occur where there is a rocky shoreline. This is a harsh environment where the plants and animals are exposed to waves, drying, heating, both land and marine predators, and people. These plants and animals have special physical and behavioral adaptations that allow them to survive the crashing waves and the daily exposure to air. At low tides exposed animals will close up, clamp down, or hide to conserve moisture and wait until the next tide comes in. One would assume it would be best for the animals to be in a tidepool where they would not dry out, but the water in a tidepool can vary in temperature, salinity, or other factors to which the animals must adapt. As the tide comes in, waves bring in a fresh supply of bubbly, oxygen-rich water to help animals breathe and plankton for them to eat. The intertidal habitat then comes alive with animals moving, feeding, and doing all that is needed for survival before the tide goes out again.

MATERIALS

- "*Let's Make A…*" sheet for each animal
- Optional: pictures of seastars, barnacles, hermit crabs, anemones, and mussels

ADVANCED PREPARATION

- Find a space where students can spread out and sit on the floor
- Put out the "*Let's Make A…*" sheet for each animal

PROCEDURE

Engage: Ask the students to describe what they think tidepools are--have them tell you what they look like and what they sound like. Discuss tides, intertidal habitat, and some of the plants and animals that live there. Let them know that the intertidal habitat includes pools of water (tidepools) but also areas where the animals are out of water for hours. Inform them that they are going to role play intertidal animals at low tide and high tide.

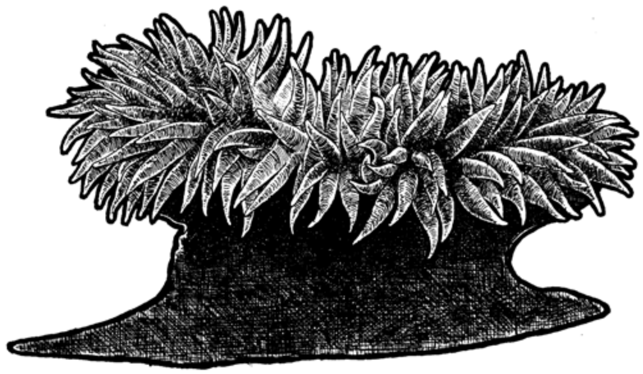
Challenge: Challenge the students to work out how their animal would behave when they are out of water at low tide.

6. Show the students the pictures of the animals. Review some of the information on each animal and demonstrate how to 'become' each animal with their bodies at high tide. Do not give them the information for low tide. This information can be found on the "*Let's Make A…*" sheet for each animal.
7. Divide the students into groups and assign each group an animal. You will need 5 students to become one seastar, 3 for each anemone, 2 for each mussel, and 1 student for each barnacle and hermit crab.
8. Give the students time in their group to decide how to role plays their animal at low tide. Each group is responsible for acting out the behavior of their animal. If needed, suggestions for how to role play at low tide is found on the "*Let's Make A…*" sheet for each animal.
9. Set the Scene:
   Crashhh!!! Wow, imagine waves crashing down on top of you every ten seconds.
   Sometimes, when the ocean is angry, those waves can be over 20 feet high.
   AAAAhhhh!! Imagine how good it feels when the cool water from the incoming tide covers you again. You have been out of the water for hours during the daily low tide. The sun has been beating down on you and you are hot and dry.
10. Create an imaginary tidepool in your classroom. Tell the students it is high tide and have them role play their animal at high tide. Then tell them it is low tide and have them role play what their animal would do. Do this several times.
11. Conclusion: Ask the students to explain why they behaved differently at high and low tide.

Discussion: See question found on each "*Let's Make A…*" sheet for each animal.

Let's Make A… Animals in the Tidepool Role-play

Sea Anemone: If you look at sea anemones underwater, you can see their stinging cells (tentacles) open in order to feed. As the tide recedes, the anemones close to protect themselves from too much sun.



Anemone Role Play:

High tide: Have the students work in groups of three. They need to stand facing each other. When the tide is high, they will put their arms up and wiggle their fingers to feed. Have the students act as if they were anemones and a small animal swims past their bodies.

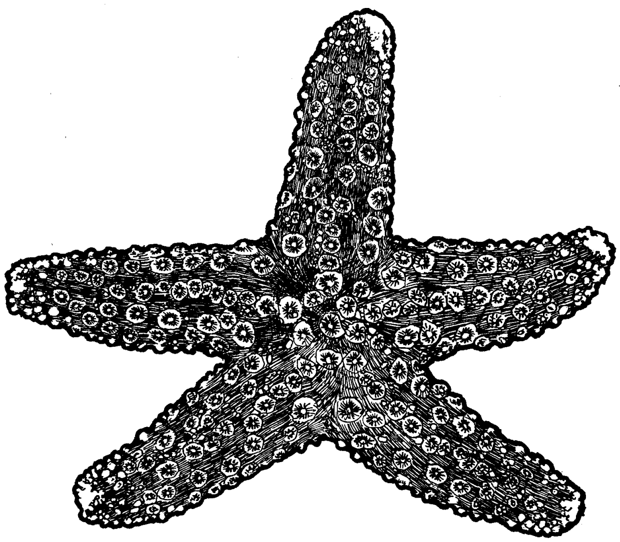
Low tide: As the tide recedes, anemones pull their tentacles into their mouth. The students can pull their arms in and cover their heads for protection. What do they do as the tide continues to go out and they are stranded out of water? Anemones contract; the students can squat down together to make a small, tight group.

Discussion Questions About Anemones:

1. What do anemones look like? (They have brightly-colored bases and a ring of tentacles.)
2. What do sea anemones eat? (Snails. They also trap small shrimp, crabs, fish, and other things.)
3. How do sea anemones eat? (The stinging tentacles close in and the sac-like body closes. The anemone digests its food.)
4. What do anemones look like when they are out of water? (They close up and shrink to half their size.)
5. How do sea anemones keep from drying out? (Before the receding tide uncovers them, sea anemones draw in their tentacles and close their sac-like bodies, with their stomachs full of seawater.)

Let's Make A… Animals in the Tidepool Role-play

Sea Star: At high tide, or when covered with seawater, sea stars move easily about in search of food. At low tide, or when out of the seawater, sea stars stop moving.



Sea Star Role Play:

High tide: Have the students work in groups of five. Each student represents a ray of a star. Have them lie on the floor with their heads touching each other. Can they make the sea star move?

Low tide: Sea stars at low tide would try to hide out of the sun and wait until water returns. Students can move and go under tables or along a wall and then stop.

Discussion Questions About Sea Stars:

1. Where do sea stars live? (On the rocks just below the mussel beds.)
2. How do sea stars move? (They move about on their many tube feet. At the tip of each tube foot is a water bulb that forms a suction cup. The tube feet work as plungers and levers to pull and shove the body forward.)
3. How do sea stars eat? (A sea star uses its tube feet to pull the mussel's shells apart. Then it slips its stomach into the mussel and digests the shellfish right in its own shell.)

Let’s Make A… Animals in the Tidepool Role-play

Barnacle: If you look at them underwater, you can see them flick their jointed legs in and out while filter-feeding and breathing.

Barnacle Role Play:
High tide: Have students lie on their backs with their legs becoming the filter-feeding ‘legs’. The students must wave and wiggle their feet around above their heads to simulate a feeding barnacle.

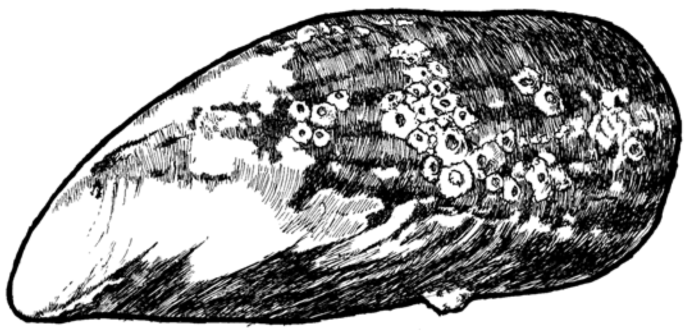
Low tide: Barnacles would pull their feeding ‘legs’ into their shell. The students curl their legs back into their chest.

Discussion Questions About Barnacles:

1. What do barnacles look like? (Barnacles have gray, volcano-shaped houses made up of six, hard, crusty plates.)
2. What does the animal inside the shell look like? (A shrimp-like animal that sits upside down with its head cemented to the bottom and its feet pointed toward the top of the shell house.)
3. How do barnacles eat? (The curled feathery legs make a net. Every second or so the barnacle thrusts out its feather legs to sweep plankton down into its mouth.)
4. Do barnacles eat at high or at low tide? (They eat at high tide.)
5. What do barnacles look like at low tide? (Barnacles show no movement or any sign of life at all.)
6. How do barnacles protect themselves from the bright sunlight? (The shell plates close tightly. As long as the tide is out, the shell keeps it moist inside.)

Let’s Make A… Animals in the Tidepool Role-play

Mussel: If you look at mussels underwater, you can see the two shells open in order to feed. As the tide recedes, the mussels close to protect themselves from the sun and predators.



Mussel Role Play:

High tide: Have the students work in pairs. They must stand facing each other. Each student in the pair represents half of the bivalve. When the tide is high, they will take a step away from each other to feed.

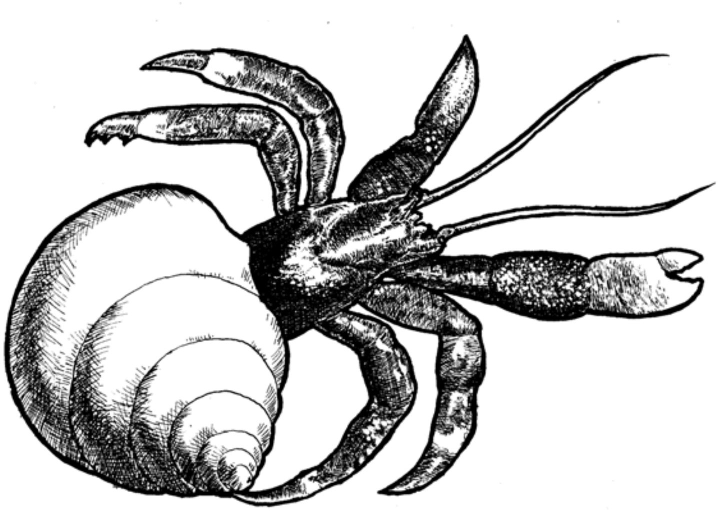
Low tide: As the tide gets lower, they step back toward each other to close for protection.

Discussion Questions About Mussels:

1. What do mussels look like? (Each blue mussel has two heavily ribbed shells, held together by an elastic hinge.)
2. How do mussels attach to rocks? (Each mussel spins long elastic anchor threads (byssal threads) to attach itself to rocks and to other mussels.)
3. What do mussels eat? (Plankton)
4. How do mussels eat? (At high tide, mussels open their shells and strain plankton from seawater.)
5. What do mussels look like at low tide? (Blue mussels sit still in the sunlight.)
6. How do mussels protect themselves from drying out at low tide? (They pull their long, thin leg inside and shut the shells together at the hinge. This holds the water inside the shell.)

Let's Make A… Animals in the Tidepool Role-play

Hermit Crab: Hermit crabs use an empty snail shell for protection.



Hermit Crab Role Play:
High tide: Each student represents a hermit crab and gets on their knees on the floor their hands become the claws. At high tide they move around on their knees using their claws to eat.

Low tide: Hermit crabs prefer to stay in tidepools but if they find themselves out of water they curl up inside their shells. Students can curl into a ball covering their head with their arms.

Discussion Questions About Hermit Crabs:

1. What does a hermit crab look like? (Hermit crabs have eyes on long stalks, two very long feelers, six legs, and a soft curled body.)
2. Why do hermit crabs live in empty snail shells? (To protect their soft, curled bodies from other seashore creatures.)
3. How do hermit crabs protect themselves at low tide? (They pull their soft bodies, their antenna, and their legs into the shell in which they live.

TIDAL MOBILE

Time: 50 minutes
Grade Level: Kindergarten-6
Group Size: 6/group
Vocabulary: tides, tidepool zones

STANDARDS
SCIENCE

- Kindergarten: 3a, 4c
- First Grade: 2a, 2b, 4d,
- Second Grade: 1a, 4b
- Third Grade: 3b
- Fourth Grade: 3a, 3b
- Fifth Grade: 3a, 6a,
- Sixth Grade: 2c, 4a,

- Kindergarten: 1.1, 1.2, 1.3, 1.4
- First Grade: 1.1, 1.2, 1.3, 2.2
- Second Grade: 1.1, 1.2
- Third Grade1.1, 1.2, 2.1, 2.2
- Fourth Grade: 1.4
- Fifth Grade:1.2
- Sixth grade: 1.1, 1.2, 1.3,

ORAL AND ENGLISH CONVENTIONS

- Kindergarten: 1.2
- First Grade: 1.1, 1.6, 1.7, 1.8
- Second Grade: 1.1, 1.2, 1.3, 1.4, 1.6, 1.7, 1.8
- Third Grade: 1.1, 1.6, 1.8
- Fourth Grade: 2.3
- Fifth Grade:1.1, 1.2, 1.3, 1.4, 1.5
- Sixth Grade: 1.1, 1.2, 1.4, 1.5

OVERVIEW

Students will understand the tidal zones and tides. They will be able to identify some animals you might expect to find in each of the tidal zones.

MATERIALS (listed per person)

- ❑ 1 large oval shaped paper plate
- ❑ 3 to 5 small circular paper plate
- ❑ String
- ❑ Crayons
- ❑ Pencil or pen
- ❑ Hole punch

PROCEDURE

Engage: Explain that everyone will be learning about the tidal zones and what animals live in each of the zones.

At this point it is up to the teacher to decide if the wish to teach the students about all five zones (splash, high tide, mid tide, low tide, and sub-tidal zones). For the kindergarten and 1st grade you may wish to discuss just the high tide, mid tide and low tide zone, for older 4th grade and above, discuss all five.

Challenge:

1. In the large plate at the top write two or three sentences describing tidepools, tides, animals, or tidal zones. Below the writing, create separations with a crayon. Label the top of each section with the tidal zones in order. You may wish to also label the far points on the plate with shore and ocean. Below each of the labels, draw a picture of the tidepools and where the water would be in each of these zones. Set aside.
2. Take one small plate and label it Low Tide Zone. On this plate use the top half to write a sentence about what the zone looks like, or how many hours a day it is covered with water, and list some of the animals that might be found in this area.
3. Repeat the process with each of the small plates and each of the zones the students are representing.
4. Using a hole punch, punch a hole in the top of each of the small plates, and below each section on the large oval plate.
5. Using an 8 inch piece of string, tie one end to the plate labeled Low Tide, and the other end to the section on the large plate labeled Low Tide.
6. Repeat this procedure for both the Mid Tide and High Tide, but use a 16 inch piece of string for the Mid tide, and a 24 inch piece of string for the High Tide zone.
7. If you are also discussing the Splash Zone and Sub-Tidal, attach the Splash Zone plate using a brad or a very small piece of string, and the Sub-Tidal plate with a 32 inch string. If the strings are too long, it is fine to shorten them, the important thing is to make sure the plates demonstrate that each of the zones is at different heights.

Discussion:

- This is a good opportunity to discuss with students how the water level changes as the tides change.
- This is also a good time to discuss with students why we can only walk on the rocks during low tide (when they are uncovered).

SLOPE AND RISING TIDE GAME

Time:	20 minutes
Grade Level:	1^{st}-5^{th} grade
Group Size:	Varied
Vocabulary:	Tide

STANDARDS

1^{st} – 2. Plants and animals meet their needs in different ways. a. Students know different plants and animals inhabit different kinds of environments and have external features that help them thrive in different kinds of places.
2^{nd} – 4. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. a. Make predictions based on observed patterns and not random guessing.
2^{nd} – (math) 1.0. Students understand that measurement is accomplished by identifying a unit of measure, iterating (repeating) that unit, and comparing it to the item to be measured. 1.3. Measure the length of an object to the nearest inch and/ or centimeter.
4^{th} – 3. Living organisms depend on one another and on their environment for survival. b. Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

OVERVIEW

The students will play a game to understand daily tidal fluctuations and the effect of slope on tidal movements along the shore. Given an imaginary rise in the tide, they will determine the new height of the water line along a slope.

BACKGROUND

See Background Information sheet on "What Causes Tides?"

It is the gravitational pull of the earth, moon, and sun upon each other that causes our tides, with the moon having the greatest effect. In California we have four tidal changes each day: two high and two low, that differ in height and time each day.
The measurement of a tide's height is the height of the water straight up. By using a tide chart and knowing the slope of a particular area, we can predict tidal movements along the shore and thus the animals that might live there. We can easily predict which areas on a beach will stay dry when it has a relatively even slope, but an uneven, rocky shoreline may be much more difficult. For example, the top of a large boulder will be out of water much longer than the bottom, making it a habitat for a variety of different inhabitants. Intertidal animals are adapted to stay out of water for different lengths of time. This forms zones of animals vertically along the shore. How large each zone is in a particular tidepool area will depend on the severity of the slope.

MATERIALS

- ❑ 50-100 ft. rope
- ❑ Level
- ❑ Yardstick
- ❑ 4-6 chairs
- ❑ Masking tape or post-it notes
- ❑ Optional: pictures of high and low tide

ADVANCED PREPARATION

- ❑ Find an outdoor area with a gentle slope to be your "intertidal area". (Wheelchair ramps may work.) Randomly designate a spot at the bottom of the slope as the "water's edge."
- ❑ Place a few chairs (to represent boulders) at different distances from the bottom of the slope.

PROCEDURE

Engage: Ask the students to imagine an intertidal area. Show them pictures of an intertidal area at high and at low tide if you have them. While the tide height (as listed in a local tide book) is the same for different shorelines in the same area, the high and low tide mark at each shore is different. The gentler the slope, the further up on the shore the high tide mark will be.

Challenge: What does a 3 foot tide change really mean? Go outside to your designated "intertidal area". Explain where the water's edge is, what represents the intertidal area, and that the chairs represent boulders. Have your students imagine they are an animal that wants to live just above the waterline, as close as it can to the water to get food but not be underwater. Tell them the tide will be coming up 3 feet. Have them put their name on the tape or post-it note and place it where they think they would want to be on the slope or on a "boulder".

To Do: This will take three people.

1. Have one student hold the yardstick at the "water's edge." They will hold one end of the rope on the top of the yardstick. The rope represents the water level.
2. Have the second student take the other end of the rope and run it up to where it meets the "shore" (slope). The rope must be held taut.
3. Have the third student use the level to make sure that the rope is held level. Where the rope intersects with the slope represents the high tide mark.

Discussion: Who got wet, who stayed dry? The winners of the game are the students who are closest to the water but not in the water. Did any of the students on the "boulders" stay out of water even if the base of the "boulder" was under water? Ask the students what effect a steeper slope would have on the high and low tide mark.

Extend: Vary the tide change or try a steeper slope. How is it different?

INTERTIDAL SAMPLING TECHNIQUES: QUADRATS

Time:	20 minutes
Grade Level:	3rd-5th grade
Group Size:	4/group
Vocabulary:	Quadrat

STANDARDS

3rd – 5. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. e. Collect data in an investigation and analyze those data to develop a logical conclusion.

3rd – (math) 2.0. Students calculate and solve problems involving addition, subtraction, multiplication, and division. 2.1. Find the sum or difference of two whole numbers between 0 and 10,000.

4th – (math) 3.0. Students solve problems involving addition, subtraction, multiplication, and division of whole numbers and understand the relationships among the operations. 3.3 Solve problems involving multiplication of multi digit numbers by two-digit numbers. 3.4. Solve problems involving division of multi digit numbers by one-digit numbers.

5th – (math) 1.0. Students display, analyze, compare, and interpret different data sets, including data sets of different sizes. 1.1. Know the concepts of mean, median, and mode; compute and compare simple examples to show that they may differ.

OVERVIEW

The students will practice one sampling technique, the quadrat method that scientists use to estimate a large population in the tidepools. They will count the number of paper clips found in a 1 ft^2 quadrat to extrapolate the total number of paper clips in a given area.

BACKGROUND

Throughout California, coastal areas are used heavily for recreational, commercial, and educational purposes. Its inhabitants are affected not only by collection or poaching, but also by water quality issues and the unintentional foot traffic of millions of visitors each year. It is important for scientists to be able to assess a population so that it can be monitored for changes over time, indicating possible ill effects that may be occurring from natural or human activity.

A quadrat count is a method used to bring a large-scale population study down to smaller units to be more easily counted and data more easily obtained. Younger students can think of the quadrat as a counting square or a device to help define boundaries to a study. By sampling several small, random areas and determining an average population density, one can extrapolate to estimate a population size over a large area.

MATERIALS

- Data Sheet
- Large and small paperclips
- Poster board or other sturdy material, stapler or glue
- Pencil
- Masking tape

ADVANCED PREPARATION

- Carefully review the Data Sheets.
- Outline one (or several, depending on class size) 4ft. x 5ft. rectangle on the floor with masking tape. Spread a box of small and a box of large paperclips throughout the area.
- Make quadrats using poster board or other sturdy material. To make a simple quadrat, cut out four equally sized strips of poster board, each 1" wide by 13" long. Staple or glue the corners of the strips together to form a square. The interior edges of the quadrat should measure 12" x 12".
- Make copies of the data sheets for each group of students

PROCEDURE

Engage: Why is it important for a scientist to know the population of an organism? Ask the students to think of different ways that a field biologist could determine the population of a particular organism over an area (blades of grass on a football field or acorn barnacles in the tidepools). It would be impractical to try and count each individual, so estimates must be made.

Explain to the students that they will use something called a quadrat to estimate a sample population in the classroom. They will be estimating a population of paperclips found on the ground to practice the method that scientists would use to count organisms in the intertidal area.

Challenge: Challenge each group of students to determine how many paperclips are within a rectangle on the classroom floor without counting them all. They must use their group's quadrats to come up with an estimate.

1. Have the student's randomly lay four quadrats within the paperclip area. Emphasize the importance of randomness in their selection.
2. Using the data sheets, have them count the number of large and the number of small paperclips within each of the four quadrats,
3. They will then use these numbers to come up with an average per square foot. The average per square foot can then be multiplied by the total number of square feet in the area (4ft. X 5ft = 20 sq. ft.) to estimate the total number in the paperclip "population".
4. Review the information on the data sheets to help students understand how this is the same data scientists would collect to determine the population of organisms in an area.

Discussion: Compare the results of the estimates from each group. Ask the students:

- Why might the results have been different for each group?
- What are some problems that biologists might have in relying on information from counts made with this method?

Discuss the different insight that might be gained by repeating this in the field over time. Do population levels change at different times of the year? Discuss the importance of the information learned from a population study of a particular area.

Intertidal Sampling Techniques: Quadrats

1) Gently drop one quadrat **per team member** onto a random spot within the 4' x 5' rectangle on the floor. Write the number of people in your group here: _______

2) Count the number of small paperclips inside each quadrat and record it in column **(a)** of the table below.

3) Count the number of large paperclips inside each quadrat and record it in the column **(b)** of the table below.

4) Add the number of small paperclips found in each quadrat together and write this number in the "TOTAL" box of column **(a)**. Do the same for the large paperclips and write this number in the "TOTAL" box of column **(b)**.

	(a) Small paperclips	**(b)** Large paperclips
Quadrat #1		
Quadrat #2		
Quadrat #3		
Quadrat #4		
Total		

5) Estimating the number of small paperclips:

Divide the total number of small paperclips by the number of people (quadrats) in your team. This is the average number of small paperclips in 1 ft^2. Write this value in the box to the right.

The 4'x5' rectangle on the floor is 20 ft^2. Multiply the average number of small paperclips by 20. This is your estimate of the total amount in the rectangle. Write this value in the box to the right.

6) Estimating the number of large specimens:

Divide the total number of large paperclips by the number of people (quadrats) in your team. This is the average number of large paperclips in 1 ft^2. Write this value in the box to the right.

Multiply the average number of large paperclips by 20. This is your estimate of the total amount in the rectangle. Write this value in the box to the right.

Lottia gigantea SHELL SIZE AND ABUNDANCE

Time:	60 minutes
Grade Level:	9th – 12th grade
Group Size:	4/group
Vocabulary:	Owl Limpets, irregular transects

OVERVIEW

Students will learn to identify a key gastropod to the rocky intertidal area of Orange County. They will measure the amount and the size of *Lottia gigantea* at two different tidepool sites. Comparing the size and abundance of this organism at two sites will help students come to their own conclusions concerning the impact of environmental and anthropogenic influences on species distribution in the tidepools.

BACKGROUND

Lottia gigantea the Owl Limpet is a common intertidal organism that has a distribution of Washington to Baja on the west coast. This gastropod can grow up to 110 mm (shell length), but individuals of this size are rarely seen in the urban influenced tidepool areas of southern California. It has been documented in several scientific studies that with increased human activity the size and number of *Lottia gigantea* both decrease.

Lottia gigantea are broadcast spawners that produce exponentially more eggs with age. They are also hermaphroditic and only the larger older individuals change to reproductive females. Humans have shown a tendency to prey on the larger or largest individuals of target populations. This has been the case with *Lottia gigantea* with the largest organisms high in the intertidal zone are often the first collected. This disturbance can greatly influence the size distribution of an entire population. Smaller females produce less young, ultimately leading to fewer individuals at a site that mature at a much smaller size.

As with any organism environmental variables may influence distribution from rock out crop to rock out crop. It is important for the instructor to determine two sites that are environmentally similar in substrate type, wave exposure, etc. to accurately compare two sites. However when the proper sites are chosen the difference in both the size and numbers of this common organism can be striking.

MATERIALS

- Meter stick or tape measure
- String or twine
- Yellow construction chalk
- Calipers
- Cones

ADVANCED PREPARATION

- Carefully review the data sheets.
- Visit the intertidal sites to determine best locations for circular plots
- Set circular plots using orange cones before class activity

PROCEDURE

<u>Engage</u>:

Have students determine the environmental variables of two intertidal sites before measuring Owl Limpet size and abundance. If possible students might record variables such as water temperature, identify the rock formation and estimate the amount of wave exposure on a qualitative scale (1-10). After looking at environmental variables ask students if they think the size and abundance of *Lottia gigantea* should differ at the two sites.

<u>Challenge</u>:

Each team will be responsible for recording the size and abundance of *Lottia gigantea* at each site. Teams will record the number and size of shell lengths of all owl limpets greater than 15 mm that fall within a 1m circular plot. Students will use calipers to measure shell length to the nearest mm. Limpets with shell lengths of less than 15 mm will not be considered as they can not easily be distinguished from other limpet species. All plots will be fixed (be in the same position) for the length of the activity at both sites. Therefore comparisons can be made between sampling periods at both sites. At each site six different reference markers will be placed at the site. With in the allotted time it is recommended that each team sample at least 3 of these plots.

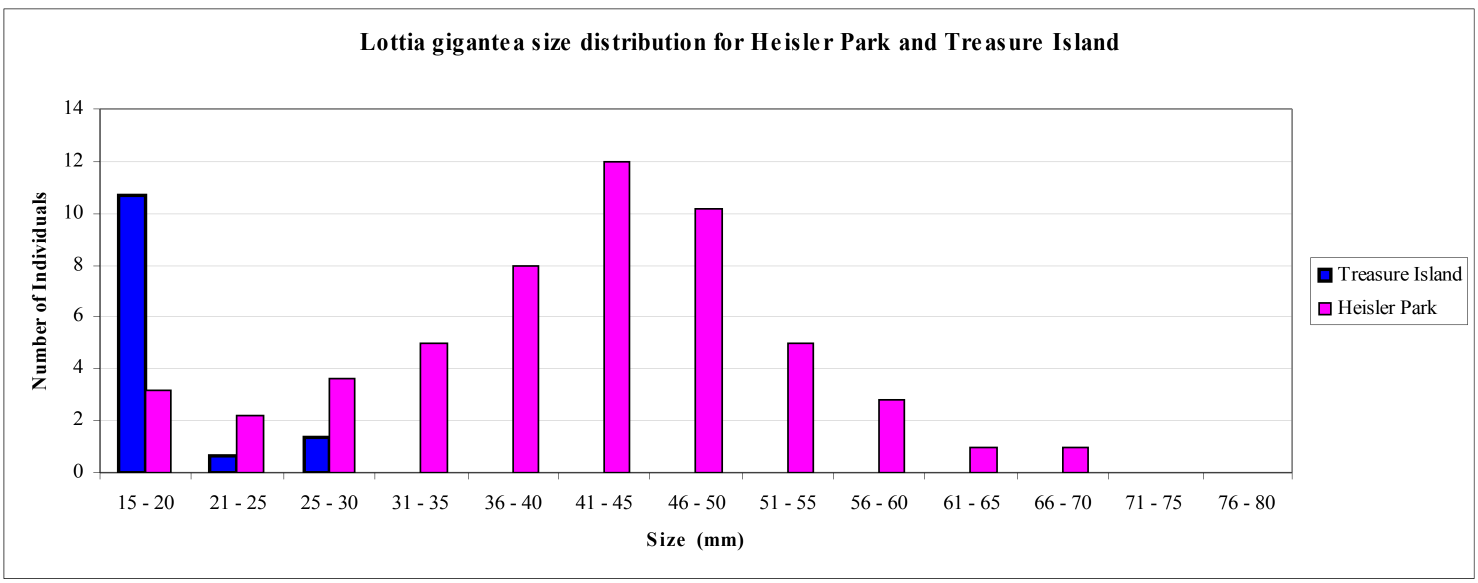
Discussion:

- What was the difference in the size and abundance of Owl Limpets at both sites chosen?
- If a difference is seen what is the cause?
- Do *Lottia gigantea* have natural predators?
- Are these predators more abundance at this site?

Follow up:
Students might be encouraged to follow up this experiment by creating an experimental design that would determine the influence humans have on both sites. Students could develop a research protocol to measure the amount and activities of humans at these two sites.

Further reading:
Kido Janine and Murray, Steven 2003. Variation in owl limpet *Lottia gigantea* population structures, growth rates, and gonadal production on southern California rocky shores. Marine Ecology Progress Series, Vol. 257, 2003.

Below is an example of data collected by Laguna Beach High School students in the spring of 2006 at Heisler Park and Treasure Island, Laguna Beach CA.



Mean size distribution for *Lottia gigantea* (Owl Limpets) for both sites Treasure Island (n = 6) and Heisler Park (n = 6). Total number of individuals sampled (abundance) at Treasure Island was 31, Heisler Park was 262.

Lottia gigantea DATA SHEET

DATE: SITE: TIME: OBSERVER: RECORDER:

Circular Plot #1				**Circular Plot #2**				**Circular Plot #3**			
Size	Count	Size	Count	Size	Count	Size	Count	Size	Count	Size	Count
15 mm		59		15 mm		59		15 mm		59	
16		60		16		60		16		60	
17		61		17		61		17		61	
18		62		18		62		18		62	
19		63		19		63		19		63	
20		64		20		64		20		64	
21		65		21		65		21		65	
22		66		22		66		22		66	
23		67		23		67		23		67	
24		68		24		68		24		68	
25		69		25		69		25		69	
26		70		26		70		26		70	
27		71		27		71		27		71	
28		72		28		72		28		72	
29		73		29		73		29		73	
30		74		30		74		30		74	
31		75		31		75		31		75	
32		76		32		76		32		76	
33		77		33		77		33		77	
34		78		34		78		34		78	
35		79		35		79		35		79	
36		80		36		80		36		80	
37		81		37		81		37		81	
38		82		38		82		38		82	
39		83		39		83		39		83	
40		84		40		84		40		84	
41		85		41		85		41		85	
42		86		42		86		42		86	
43		87		43		87		43		87	
44		88		44		88		44		88	
45		89		45		89		45		89	
46		90		46		90		46		90	
47		91		47		91		47		91	
48		92		48		92		48		92	
49		93		49		93		49		93	
50		94		50		94		50		94	
51		95		51		95		51		95	
52		96		52		96		52		96	
53		97		53		97		53		97	
54		98		54		98		54		98	
55		99		55		99		55		99	
56		100		56		100		56		100	
57		101		57		101		57		101	
58		102		58		102		58		102	
Total Plot #1 =				Total Plot #2 =				Total Plot #3 =			