Title
Invertebrate Investigators: Curriculum Development for Ocean Discovery Institute's SEA Series

Author
DiIullo, Dani

Publication Date
2009-04-01

Invertebrate Investigators: Curriculum Development for Ocean Discovery Institute's SEA Series

Danielle DiIullo
January 20, 2009

Committee:

Greg Rouse

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John Czworkowski

Eric Simms

Overall Goal:
To develop an interactive curriculum that exposes 3rd graders to the marine intertidal zone and fosters curiosity in science and the natural world.

Background:

Science is an interesting subject for students. There are preconceived notions about it, even before the first lesson is taught. There is the myth of the indecipherable scientist in the lab coat and the formulas that will be forced into memory. Essentially, it's math disguised as a different subject. It is easy to break this stereotype, if you start working with students early and often in a setting that allows them to see science as inquiry, not tedious work. Despite this, American students are still underperforming when compared to their international cohorts (Glod 2008). This underperformance becomes even more pronounced in urban areas. Urban students were found to do worse than the national average, with the gap widening as student's matriculated to higher grades (Zuckerbrod 2006).

One solution to this systemic underperformance is providing interactive science experiences. Studies have shown that students who routinely engage in hands-on science lessons have performed remarkably better (Piaget 1986, Haury and Rillero 1994, Stohr-Hunt 1998). The earlier students can have positive, interactive relationships with science, the better. These interactions can be particularly difficult for urban students, who have limited access to natural environments and therefore limited exposure. This is why the Ocean Discovery Institute has the SEA Series program targeting urban elementary and middle students in the San Diego area. And this is why I find this program particularly valuable, because it supplies an obvious need in the community.

Overview:

For my project, I will be working with Ocean Discovery Institute (previously Aquatic Adventures) to develop curriculum for the 3rd grade SEA Series program. This program deals with intertidal invertebrates and their unique adaptations. The primary goal will be produce quality material that meets California State Standards, with a secondary goal of achieving National and Ocean Literacy Standards. Throughout this project there are two different types of material that I will be working on: a classroom series of lessons and supplementary teacher-guided lessons.

The first series will consist of four lessons and experiments to be taught by Ocean Discovery Institute staff in the classroom (from here on out referred to as ODI lessons). These lessons will be primarily science based targeting specific goals: microscope usage, dissection, experimental design, etc. At the end of the program students will participate in a field trip to the intertidal zone and a community service project in their area.

In addition to these materials, I will also develop lessons to be taught by the 3rd grade teachers in the classroom (from here on out referred to as supplemental lessons). These will be compiled in a handbook to be distributed to teachers before the start of the program. There will be two pre-lessons to provide background information preparing students for the upcoming ODI lessons. There will also be two post-lessons built around reinforcing previous concepts. These lessons will be designed to meet other California State Standards such as Math, Language Arts and Social Studies.

Finally, I will see the curriculum in action by assisting the Ocean Discovery Institute team in the classrooms. We are working with six different schools in the University Heights area: Encanto, Kit Carson, Kimbrough, Memorial, Montgomery and O'Farrell Community School. Each school has several participating classrooms with twenty students each. In total, over 500 3rd graders will participate in the program. This will also allow time for discussion with the classroom teachers to see where further improvements can be made.

Objectives:

1. Edit and enhance existing SEA Series classroom curriculum
    - 4 ODI lessons, field trip and service project
2. Develop two pre- and two post-lessons for teachers involved with SEA Series to implement in their classrooms
    - 8-12 supplemental lessons
3. Assist instruction of SEA Series 3rd grade curriculum
    - At least once or twice a week, schedule pending

Works Cited

Glod, Maria. "Scores on Science Test Causing Concern in the U.S." The Washington Post. December 10, 2008.

Haury, David and Rillero, Peter (1994). Perspectives of Hands-On Science Teaching. Columbus: ERIC Clearinghouse for Science, Mathematics and Environmental Education

Piaget, Jean (1986). Science of education and psychology of the child. The Essential Piaget: And Interpretive Reference Guide. New York: Basic Books.

Stohr-Hunt, Patricia. "An Analysis of Frequency of Hands-on Experience and Science Achievement". Journal of Research in Science Teaching. 33 (1): 1998.

Zuckerbrod, Nancy. "Urban students do worse than nation in science." The Boston Globe. November 15, 2006.

Lesson Overview:

LIFE ON THE ROCKS

Pre-Life on the Rocks:

Ocean Tide Pool : The class reads Ocean Tide Pool by John L'Hommedieu aloud and then completes a worksheet comparing rocky seashore invertebrates with local canyon invertebrates.

Invertebrate Story Problems : Students improve their math fluency by solving invertebrate story problems in the rocky seashore using addition, subtraction and multiplication.

Post-Life on the Rocks:

Suki and the Magic Sand Dollar : After reading the chapter book Suki and the Magic Sand Dollar, students will record observations made in the book and later make observations of nature on their own.

Ocean Motion : Students get an introduction to waves and how they are created through two activities. Other forms of waves – not just ocean waves are discussed.

MEET AND GREET

Pre-Meet and Greet:

Invertebrate Fractions : Students become more familiar with fractions through the use of invertebrate examples. Inverts with well known body segmentation are used.

Newberry: The Life and Times of a Maine Clam : Students read chapters from the book Newberry: The Life and Times of a Maine Clam by Vincent Dethier and then complete a food web based upon the trophic interactions in the book.

Post-Meet and Greet:

Spineless Suspects : Students receive clues from various crime scenes with invertebrate perpetrators. Using the characteristics of different organisms they determine which invertebrates are responsible for which crime.

Invertebrate Elections : The class will be presented with four candidates running for president. The candidates each have unique stances on various issues facing the ocean; students will read these and then try and understand the different campaigns of the invertebrates.

INVERT INSIDERS

<u>Pre-Invert Insiders:</u>

Dichotomous Key (Day 1) : The class gets introduced to the concept of distinguishing differences in organisms through the use of a dichotomous key. After a trial run with cartoons, the students will be able to use a dichotomous key to classify various invertebrates.

Dichotomous Key (Day 2) : After gaining experience with dichotomous keys from the previous lesson, the students will get the chance to play scientist and create their own dichotomous key for various local canyon invertebrates.

<u>Post-Invert Insiders:</u>

Squid Dissection : Dissection time continues with dissections of the California market squid *Loligo opalescens*.

Invert Infants : Students will gain familiarity with the life cycles of various invertebrates through solving clues about the invertebrates identity. The classic example of the butterfly will be used to provide comparison for various life cycle changes.

3-D ROCKY SEASHORE

<u>Pre-3-D Rocky Seashore</u>

American Indian Invertebrate Trade : Students will become familiar with the role that invertebrates played in the trade of the Kumeyaay Indians. They will use shells of various values to purchase various Kumeyaay items.

Ancient Oceans : Students look compare how previous oceans looked compared to present day. In doing so they gain an understanding of how some animals are better suited to environments and others go extinct.

<u>Post-3-D Rocky Seashore</u>

Teaching Tides : After learning about how the sun and moon affect tides on earth, students begin a month long experiment/observation where they try and determine which lunar alignments result in spring tides and which lunar alignments result in neap tides.

Scientific Careers : After reading a summary of a researcher in <u>Talking with Adventurers</u>, students play the role of various scientists and are then interviewed by their fellow classmates.

FIELD TRIP

Pre-Field Trip

Diversity and Abundance : What is diversity? Look at forest leaf litter- many species, but not many phyla. Contrast with seashore, where have many phyla. Is diversity number of species or phyla, etc.

Once Upon a Storm Drain : After reading the short story Once Upon a Storm Drain, students have the opportunity to create their own adventure involving storm drain travel.

Post- Field Trip

Inspect an Invert : In this activity, students will be given an image of a deep sea invertebrate. Using the knowledge that they have gained in the previous weeks they will attempt to draw conclusions about this creature based upon its appearance.

Ocean Exploration : Students become members of a deep sea research crew exploring hydrothermal vents. Through their expedition, they create a journal recounting what they've done and what they've seen.

COMMUNITY SERVICE

Pre-Community Service

Marine Debris : Students read letters from various animals in the ocean talking about the problems of marine debris. Then students will write their own letters to a local politician explaining the problems that marine debris causes in the ocean.

Ocean Acidification : The class examines the effects a more acidic ocean can have on its organisms. After an experiment, they then begin to hypothesis about what will happen to one local species- the bubble snail.

Post-Community Service

No Fish in my Dish : The students will read a story about how overfishing can affect an entire community. After reading they will engage in a mock debate over the decision to make the bay a no-take zone.

Lobster Wars : Students will get to experience first hand what the fishing industry is like and the consequences that it can have on the environment and the economy through an activity based on lobster fishing.

Animal Observation Journal

Name: ______________________

Draw the animal:	Location:	Observations:
Sand Piper (pp. 22-23)		
Pelican (pp. 29-30)		
Horseshoe Crab (pp. 35-36)		
Sea Turtle (pp. 50-53)		
Sand Dollar (pp. 60-62)		

Ocean Waves

Goal:

- Students are able to understand the basic mechanics of waves and their formation.

Objectives:

- Students are able to identify two part of the wave.
- Students are able to understand how waves are formed.

CA Standards:

Science

3.1.d. Students know energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

National Standards:

Science

NS.K-4.1 Science as Inquiry

NS.K-4.2 Physical Science

Materials:

- 2-liter bottle
- Food coloring
- Electrical tape (or some other way to seal the bottle cap on)
- Rubbing Alcohol
- Paint thinner
- Shallow baking pan
- Water

Setup:

- Clean and dry out a 2-liter bottle
- Set up one shallow baking pan at each table group
- Put the rest of the materials at the front of the classroom for demonstration

Procedure:

Introduction (20 minutes)

- Ask students what are some of physical factors that make living at the rocky seashore difficult. *Potential answers include: waves, drying out, saltiness, exposure to sun, etc.*
- Tell the class that they are going to learn more about one of these environmental – waves.

- Ask students if they know how waves are formed. Tell them they are formed by wind. Wind provides energy that moves through the water creating waves.
- To test this fact, have the students fill up the shallow baking pans at least half full with water. Then have them put a drop of food coloring in one corner (any color other than yellow which is hard to see).
- Now tell the students that they need to provide the wind necessary to make the waves. They can either use an electrical fan, make a fan out of paper or simply blow on the water. Slowly they will watch the color start to fan out from the corner as they create waves. The expansion of the color represents the energy that is being transferred throughout the water.
- Next ask the students to imagine that the baking pan represents an ocean where there are lots of waves. Ask the students if they think that the water in one wave would travel all the way across the ocean (if they need have them observe the baking pan a few more times). *Answer: No.*
- Explain to students that the only thing that is moving across the ocean (or horizontally) is the energy. Water waves only move vertically (up and down) not horizontally. The waves they are creating in their pan are from an up and down movement, if they look closely the water itself does not move across the pan at all. Give students another couple minutes to try this again.
- Tell students that if all the Earth's water moved across (or horizontally), then there would be holes forming in the tray. The water is passing the energy along to the surrounding water.
- We know this is true because if all the ocean water moved it would be piled up on the beach, not evenly distributed like it is on Earth.

Main Activity (20 minutes)

- Now that the class is familiar with waves, tell the students that they are going to be able to identify the different parts of a wave. To do that explain that you are going to create an ocean in a bottle.
- Take the 2-liter bottle and fill it up half way with rubbing alcohol.
- Next add some food coloring, preferably blue.
- Then fill the remainder of the bottle with paint thinner (as an alternative to rubbing alcohol and paint thinner, water and baby oil can be used).
- Place the cap on, screw it tight and wrap the lid with some type of waterproof tape – like electrical tape.
- Finally, turn the bottle on its side so students can see how the bottle mimics the ocean waves. Pass it around so that each student has an opportunity to examine it – noting the highs and lows.
- Draw a series of waves on the board.
- Ask the students if they know what the highest part of a wave is called. *Answer: a crest.* Label the crest on one of the waves.
- Ask the students if they know what the lowest part of a wave is called. *Answer: a trough.* Label the trough on one of the waves.

- Ask the students how they would measure how long a wave is. *Answer: wave distance is measured from either one crest to the next crest or from one trough to the next trough.* This distance is called wavelength. Draw a line connecting one crest to another and label it wavelength.
- Ask the students how they would measure how tall a wave is. *Answer: wave height is measured from the trough to the crest.* Draw a line connecting a trough to a crest and label it wave height.
- Studying waves and currents is a very important part of studying the ocean – it is called physical oceanography. Understanding waves is not just important for scientists. Surfers understand waves so they can ride them better. Boatman and yachters need to understand waves for transportation purposes. Shipping companies study waves and current so they can find the best routes to ship their freight across the ocean.

Closing (10 minutes)

- Tell students that water isn't the only substance that moves by waves. Sound travels in waves and that's why they're called sound waves. Light also travels in waves.
- Ask the students how these different waves are created. *Answer: the same way that ocean waves are created - by energy.*
- Waves can carry tremendous amounts of energy, in particular large, long waves called tsunamis. These waves are usually the result of earthquakes, submarine landslides or other under surface disturbance. These types of waves are very difficult to predict and can be devastating – one such wave killed hundreds of thousands in December 26, 2004.
- It is important to understand waves in general to create a system for notifying people, boats and countries about changes in waves. A notification system in 2004 could have saved many lives.

Suki and the Magic Sand Dollar
By Joyce Blackburn

Goal:
- Students are able to develop the scientific skill of observation and recording, and distinguish different ecosystems by reading the short story Suki and the Magic Sand Dollar.

Objectives:
- Students are able to explain the importance of observation in the scientific process.
- Students are able to list at least two observations from the text and one observation that they made on their own.

CA Standards:

Science

3.5.a Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

Reading Comprehension

2.3 Demonstrate comprehension by identifying answers in the text.

2.6 Extract appropriate and significant information from the text, including problems and solutions.

Writing Applications

2.2 Write descriptions that use concrete sensory details to present and support unified impressions of people, places, things, or experiences.

National Standards:

Science

NS.K-4.1 Science as Inquiry

NS.K-4.3 Life Science

Materials:
- Suki and the Magic Sand Dollar by Joyce Blackburn
- Animal Observation Journal (provided)
- Pencil

Setup:
- Make one copy of the Animal Observation Journal for each student

Procedure:

Introduction (10 minutes)

- So far the students have been primarily studying the rocky seashore. Inform the class that they are going to start a reading unit about a girl exploring a different type of seashore habitat-the sandy beach habitat of a barrier island. A barrier island is a long, skinny piece of land that runs parallel to the mainland. It is the result of wave action and currents and can protect the mainland coastline. Ask students how they think the sandy beach will be different from the rocky seashore. *Potential answers: no solid substrate, erosion of sand, less algae growing in habitat, greater exposure to waves, etc.*
- Tell the students that in their previous lessons with Ocean Discovery Institute they have learned how to be good scientists. One part of being a good scientist is being a good observer and recording your observations.
- Observation is an extremely important part of the scientific process. Scientists are trained to notice patterns and changes in nature. In order to make these patterns and changes known to others, they must first record their observations.
- Tell the students that in this activity they are going to further develop their scientific observation skills and record their observations.

Main Activity (20 minutes)

- Introduce Suki and the Magic Sand Dollar to the class. Tell them that the main character Suki is very good at observing nature. During the story, Suki visits Saint Simons Island in Georgia with her parents. Saint Simons is a barrier island with sandy beaches.
- Select a few paragraphs that adequately demonstrate this (see Animal Observation Journal for some suggested pages). Read the section out loud to the class to provide an example.
- Tell the students that as they read through this book, they will be looking for sections like this that describe nature (students may either be assigned the entire book to read or the selected passages in the Animal Observation Journal). After they have read the sections they are going to record the observation in their Animal Observation Journal.
- Hand out the Animal Observation Journal.

Conclusion (25 minutes)

- Have the students pull out their completed Animal Observation Journal. Review some of the observations that the students recorded as a class.
- Next have the students note that there is still a blank entry at the bottom of the Animal Observation Journal worksheet.
- Now tell the students that they will be get the chance to be Suki and make their own observations. Tell the class that they are going to go outside to the playground, canyon, garden, etc. and observe nature. They will record the information in the empty box located at the bottom of the worksheet.
- They can observe any kind of nature – as long some kind of animal. They can look at bugs, birds, squirrels, etc. Students should work independently on this assignment, not in large groups.
- After 10 or 15 minutes of quiet observation have the students share their observations with the class.

Invertebrate Story Problems

Goal:

- Students will gain familiarity with story problems using mixed addition, subtraction and multiplication.

Objectives:

- Students will gain familiarity with story problems using mixed addition, subtraction and multiplication to study the invertebrates of the rocky seashore.

CA Standards:

Number Sense

3.2.1. Students find the sum or difference of two whole numbers between 0 and 10,000.
3.2.2. Memorize to automaticity the multiplication table for numbers between 1 and 10.
3.2.8. Solve problems that require two or more of the skills mentioned above.

Materials:

- Invert Story Problems worksheet (provided)
- Practice Problems Transparency (provided)
- Rocky Seashore Habitat worksheet (provided)
- Markers, Colored Pencils or Crayons
- Pencils

Setup:

- Draw an empty square on the board in which a rocky seashore will be created
- Make one copy of the Invert Story Problems worksheet per student
- Make one copy of Rocky Seashore Habitat worksheet per student

Procedure:

Introduction (25 minutes)

- If the class did not do the previous Ocean Tide Pool lesson - ask the students what they think the rocky seashore is like. It is a rocky place where the land meets the ocean. There are waves, it is dry and sunny sometimes and under water at other times. The animals that live there need to be adapted to deal with these changes.
- Ask students if they remember what an invertebrate is. *Answer: an animal without a backbone*.
- Ask students to name as many invertebrates as they can that live in the rocky seashore. Write the names on the board. Tell students that they are going to use their math skills to build a rocky seashore habitat for many of these animals.
- Go through an example of the processes on the board. Use the Practice Problem overhead to demonstrate how to read the story problem, find an answer, and translate the answer into a rocky seashore drawing.
- Explain that we need to do is to make a habitat for our invertebrates. Step one says: "Draw a picture of a rocky seashore habitat." Draw a picture of the rocky seashore in the square on the board.
- Tell students that now that we have a habitat, we can add invertebrates

- Have students read step two: "Draw two barnacles in the habitat. How many invertebrates are in the rocky seashore?" Draw the two barnacles on the board. Ask the students how many invertebrates are in the rocky seashore. *Answer: two.* Write the answer on the overhead.
- Have a student read step three: "Draw three sea stars in the habitat. If each sea star has five arms, how many total arms do the three sea stars have?" Draw three sea stars on the board. Ask how much three times five is. Answer: fifteen. Write each of the answers in the blanks on the overhead.
- Continue going through each step of the Practice Problems until your habitat is complete.

Main Activity (30 minutes)
- Pass out the Invert Story Problems Worksheet to each student. Explain to the students that they will each be creating their own rocky seashore habitats with invertebrates.
- Allow students time to make their rocky seashores look realistic by coloring them and adding more details.

Closing (5 minutes)
- Review answers to worksheets with students.
- Have students share their finding on how many of each type of animal live in their habitat.
- Drawings may be hung around the room, if space is available.

Name:____ Date:____________________________

Practice Problems

1. Draw a picture of a rocky seashore habitat.
2. Draw two barnacles in the habitat. How many invertebrates are in the rocky seashore?

   ______ invertebrates

3. Draw three sea stars in the habitat. If each sea star has five arms, how many total arms do the three sea stars have?

   ______ sea stars x ______ arms on a star = ______ total arms

4. There were fifteen snails in the rocky seashore, but birds ate seven of them. How many snails are left?

   ______ original snails - ______ snails eaten = ______snails left
   Draw the remaining snails in the rocky seashore.

5. Draw two octopi in the rocky seashore. If each octopus has eight arms, how many total arms do the two octopi have?

   ______ octopi x ______ arms on an octopus = ______ total arms

6. There are six more sea anemones than sea stars in the rocky seashore. How many sea anemones are in the habitat?

   ______ sea stars + ______ = ______ sea anemones
   Draw the anemones in the rocky seashore.

7. How many total invertebrates are in the rocky seashore now?

   ______ barnacles

   \+ ______ sea stars

   \+ ______ snails

   \+ ______ octopi

   \+ ______ sea anemones

   ______ invertebrates

Practice Problems: Answer Key

1. Draw a picture of a rocky seashore habitat.
2. Draw two barnacles in the habitat. How many invertebrates are in the rocky seashore?

   __2___ invertebrates

3. Draw three sea stars in the habitat. If each sea star has five arms, how many total arms do the three sea stars have?

   __3___ sea stars x __5___ arms on a star = __15__ total arms

4. There were fifteen snails in the rocky seashore, but birds ate seven of them. How many snails are left?

   __15__ original snails - __7___ snails eaten = __8___snails left
   Draw the remaining snails in the rocky seashore.

5. Draw two octopi in the rocky seashore. If each octopus has eight arms, how many total arms do the two octopi have?

   __2___ octopi x __8___ arms on an octopus = __16__ total arms

6. There are six more sea anemones than sea stars in the rocky seashore. How many sea anemones are in the habitat?

   __3___ sea stars + __6___ = __9___ sea anemones
   Draw the anemones in the rocky seashore.

7. How many total invertebrates are in the rocky seashore now?

   __2___ barnacles

   \+ __3___ sea stars

   \+ __8____ snails

   \+ __2____ octopi

   \+ 9 sea anemones

   __24___ invertebrates

Name:______________________________________ Date:________________________

Invertebrate Story Problems

1. Draw a picture of a rocky seashore habitat.

2. Draw two sea stars in the habitat. How many invertebrates are in the rocky seashore?

   ______ invertebrates

3. Draw three crabs in the habitat. If each crab has ten legs, how many total legs do the three crabs have?

   ______ crabs x ______legs on a crab = ______ total legs

4. There were twelve mussels in the rocky seashore, but the sea stars ate five of them. How many mussels are left?

   _____ original mussels - _____ mussels eaten = _____mussels left
   Draw the remaining mussels in the rocky seashore.

5. There are four more jellies than crabs in the rocky seashore. Draw the number of jellies in the rocky seashore.

   ______ crabs + ______ = ______ jellies

6. There are two fewer barnacles than jellies. Draw the number of barnacles in the rocky seashore.

   ______ jellies - ______ = ______ barnacles

7. How many total invertebrates are in the rocky seashore?

   ______ sea stars

   \+ _____ crabs

   \+ ______ mussels

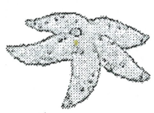
   \+ ______ jellies

   \+ ______ barnacles

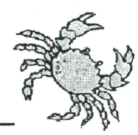
   ______ invertebrates

Name:______________________ Date:______________________

Rocky Seashore Habitat



______ Sea Stars



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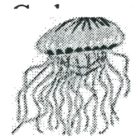
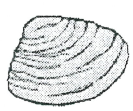
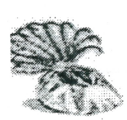




______ Mussels

______ Jellies



______ Barnacles

Invertebrate Story Problems: Answer Key

1. Draw a picture of a rocky seashore habitat.
2. Draw two sea stars in the habitat. How many invertebrates are in the rocky seashore?

   __2___ invertebrates

3. Draw three crabs in the habitat. If each crab has ten legs, how many total legs do the three crabs have?

   __3___ crabs x __10__legs on a crab = __30__ total legs

4. There were twelve mussels in the rocky seashore, but the sea stars ate five of them. How many mussels are left?

   __12__ original mussels - __5__ mussels eaten = __7__mussels left
   Draw the remaining mussels in the rocky seashore.

5. There are four more jellies than crabs in the rocky seashore. Draw the number of jellies in the rocky seashore.

   __3___ crabs + __4___ = __7___ jellies

6. There are two fewer barnacles than jellies. Draw the number of barnacles in the rocky seashore.

   __7___ jellies - __2___ = __5___ barnacles

7. How many total invertebrates are in the rocky seashore?

   __2___ sea stars

   \+ __3___ crabs

   \+ __7____ mussels

   \+ __7____ jellies

   \+ __5____ barnacles

   __24___ invertebrates

Ocean Tide Pool
by John L'Hommedieu

Goal:
- Students will learn that all invertebrates have adaptations unique to the habitat they live in by comparing invertebrates from the rocky seashore with invertebrates from a local canyon.

Objectives:
- Students will be able to extract at least two pieces of information and use it to compare and contrast with existing knowledge.
- Students will be able to name at least one invertebrate from the rocky seashore and one of its adaptations.
- Students will be able to name at least one canyon invertebrate and one of it adaptations.

CA Standards:

Reading

3.2.6. Extract appropriate and significant information from the text, including problems and solutions.

Science

3.3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

3.3.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

National Standards:

Science

NS.K-4.1 Science as Inquiry
NS.K-4.3 Life Science

Materials:
- Ocean Tide Pool by John L'Hommedieu (5 copies provided per class)
- Ocean Tide Pool Worksheet (provided)
- Pencils, markers, crayons, or colored pencils
- Terrestrial Invertebrate Cards

Setup:
- Before the book is read with the students, be sure to preview the text and pull out any vocabulary or concepts that the students may have difficulty with. Write these vocabulary terms and concepts down so that they can be discussed as they are read within the text.
- This lesson can be done in guided reading groups or read aloud. Copies of the text can be used (text is attached) for students to follow as it is read aloud to the class.

Procedure:

Introduction (10 minutes)

- Gather the students in the front of the class and explain that they are going to be reading Ocean Tide Pool by John L'Hommendieu. It is a book filled with information about rocky seashore animals living in a tide pool. Most of the animals that live in the rocky seashore are invertebrates. Ask if anyone in the class knows what an invertebrate is? Tell them that an invertebrate is an animal without a backbone.
- Ask the class what they think it is like at the rocky seashore. The rocky seashore is a rocky place where the land meets the ocean. There are waves, it is dry and sunny sometimes and under water at other times.
- Review with students what an adaptation is. *It is a change in which a species becomes better suited to its environment*. The species could be plants, animals, bacteria, etc. Every environment offers unique challenges to the species that live there; these species over time become better adapted to their environment or can potentially go extinct. The invertebrates in the rocky seashore have adaptations that allow them to survive in their habitat.
- Ask the students if they think invertebrates can live other places besides the rocky seashore. Have students name places where they might find invertebrates that live around them. *Possible answers include: canyons, houses, woodlands, grasslands, deserts, etc.*
- Explain that right outside their classroom the bushes, trees, plants and canyons provide habitat for invertebrates. Ask the students what kind of invertebrates they might find in these places. *Possible answers include: any species of insects, spiders, millipedes and centipedes.*
- Explain that once the class is done reading the book they are going to choose one invertebrate from the rocky seashore and compare it to an invertebrate located in the canyons by their school.

Main Activity (35 minutes)

- Read the story aloud. Once the book has been finished, ask the group why they think it would be difficult for animals to live in the rocky seashore. *Possible answers include: waves and tides changing water levels, drying out during low tides, sun exposure, finding food, humans altering their habitat etc.*
- Ask students to give examples of some of the invertebrates that live in the rocky seashore. *Possible answers include: sea stars, crabs, urchin, barnacles, sea anemones*. Ask what kind of adaptations they have that allow them to live there. Have the students give examples of adaptations and explain how it helps them survive in the rocky seashore. *Possible answers include: hard outer shell, claws, stinging cells, suction cups, regeneration.*
- Explain to the students that they will be doing the same for a local invertebrate. Provide the terrestrial invertebrate information cards for students to examine. Ask students to think of some potential difficulties invertebrates that live in the canyon might have to deal with. *Possible answers include: predators, heat, lack of water, finding food, erosion, humans altering their habitat.*
- Ask students to think of adaptations the canyon invertebrates have to help them survive in the canyon. *Possible* answers *include: burying themselves in moist ground, living in cooperative groups, having a protective covering.*
- Explain that the students will each be choosing one invertebrate from the rocky seashore and one from the local canyon and will compare and contrast them.
- Review compare and contrast if necessary.
- Pass out the Ocean Tide Pool worksheet to each student and have them answer the questions.

Closing (15 minutes)

- Have students discuss their findings. Ask them what were some of the similarities between the two organisms. Ask them what were some of the differences
- Explain that animals are not the only species that can adapt to their environments. Plants, fungi, bacteria and others can too. Any living thing can adapt. Have students think what adaptations plants might have to survive in both the rocky seashore and the canyons.
- The students have now learned about two types of habitats: the rocky seashore and canyons. Have them think about other habitats that exist. Possible answers: open ocean, tropical rainforest, desert, woodland, coral reef, etc. For each different habitat that the students list, have them think about an adaptation that species would need to have to survive there.

Name:______________________________________ Date:_________________________

Ocean Tide Pool Worksheet

Draw your rocky seashore invertebrate below.

Describe what it is like at the rocky seashore?
(Is it hot or cold, wet or dry, etc.)

List 2-3 adaptations of this invertebrate?

Draw your canyon invertebrate below.

Describe what it is like at the canyon?
(Is it hot or cold, wet or dry, etc.)

List 2-3 adaptations of this invertebrate?

What is similar about these two invertebrates? *Hint: Segmentation of the body, how they move, how they obtain food, how many there are, ways that they change their environment, etc.*

What is different about these two invertebrates? *Hint: Number of legs, number of body parts, antennae, color, shape, etc.*

Invertebrate Elections

Goal:
- Have students understand the political process and the role of citizens in government through a mock invertebrate election.

Objectives:
- Students are able to identify at least two different political issues commonly discussed in elections.
- Students are able to describe the basics of the political process.

CA Standards:

Science

3.3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

Social Studies

3.4.1. Determine the reasons for rules, laws and the U.S. Constitution; the role of citizenship in the promotion of rules and laws; and the consequences for people who violate rules and laws.

Reading Comprehension

3.2.3. Demonstrate comprehension by identifying answers in the text.

3.2.6. Extract appropriate and significant information from the text, including problems and solutions.

Literary Response and Analysis

3.3.3. Determine what characters are like by what they say or do and by how the author or illustrator portrays them.

National Standards:

Science

NS.K-4.3 Life Sciences

Materials:
- Invertebrate Candidate Ballot paper (provided)
- Invertebrate Election Worksheet (provided)

Set-up:
- Make copies of Invertebrate Candidate Ballot paper-one per student
- Make copies of Invertebrate Election Worksheet-one per student

Procedure:

Introduction (15 minutes)

- Ask the students if they know what big political event occurs in early November. *Answer: an election.* Ask the students what are some of the things that are voted on? *Answer: candidates (such as president, congressmen, representatives, etc.) and issues (environment, health care, taxes, etc.).*
- Remind students that elections offer a great opportunity for citizens to have a voice in their country's decision-making process. If they like or don't like the way the government is doing things, they can potentially change that by voting and getting involved.
- Explain to students that voting for candidates is very important because they are our representatives in the government. Candidates should reflect how the majority of the people feel about a certain topic.
- Tell the students that when a candidate runs for office they have to tell voters how they plan to vote on many topics from how much they think people should pay in taxes each year to whether or not they think the environment should be protected.
- Voters typically vote for a candidate who has similar opinions to them on many topics.

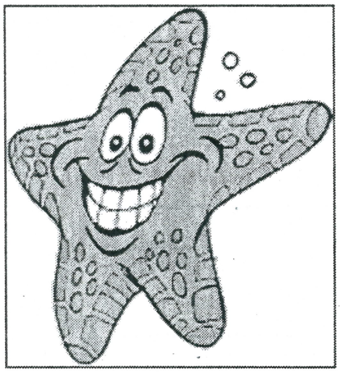
Main Activity (30 minutes)

- Now tell the students that they will be participating in their own election , they will be voting on the next Pacific Ocean Undersecretary of Sea and all of the candidates are invertebrates.
- The first thing responsible citizens do when they are deciding on who to vote for is they do research, just like scientists. They find out how the candidate stands on a variety of issues.
- Explain that the first thing they are going to do is learn some background information on the different candidates by reading the Invertebrate Candidate Ballot sheet.
- Tell the students that the Ballot sheet is filed with very important information about how each of the invertebrate candidates stands on certain issues.
- In order to ensure that the students have carefully read the information, they will then fill out the Invertebrate Election Worksheet based upon what they read.

Closing (10 minutes)

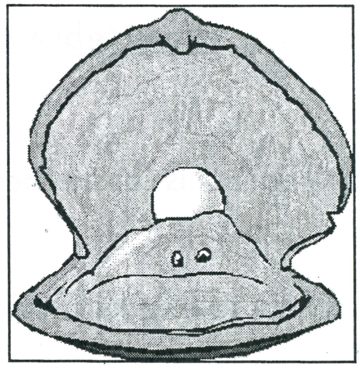
- Tell the students that they we will now engage in a mini-election. Assure them that their vote will remain anonymous. Remind them that this is one of the nice features of democracy-that they can vote for who they like and they are not obligated to reveal their voting preferences.
- Pass out scrap pieces of paper and have each student write the name of the candidate that they would vote for on a scrap piece of paper. Remind students that they are voting for the candidate who's views they agree most with, not their favorite rocky seashore invertebrate.
- When they have finished have them fold up the paper and collect them.
- Take a moment to tabulate the results and if there is a clear winner then announce who the new Pacific Ocean Undersea Secretary of the Sea is. If there is a tie, have a run-off between the two candidates with the most votes.
- Explain to students that not everyone voted for the invertebrate candidate who won. Ask students what they think about the fact that some people's views and ideas my not be represented in the government.
- Ask students if they think this happens in the real government. Ask students what they think they could do if the candidate they did not vote for won.

Invertebrate Candidate Ballot



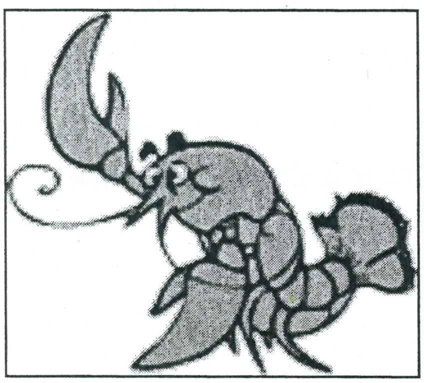
Sandra Sea Star

As a member of the Echinodermata Party, I am a firm believer in regeneration. If I can regenerate arms, this undersea land can regenerate jobs. I strongly support expanding the number of jobs here in this ocean and want to stop the flow of jobs to the other oceans.



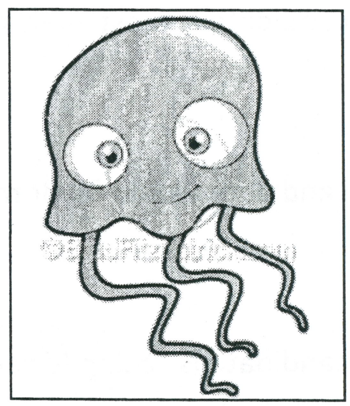
Ollie Oyster

As a member of the Mollusca Party, I am a firm supporter of the environment. For centuries I have been doing my part in filtering out harmful chemicals in our ocean. I now believe that it is time for the rest of the undersea population to stand up a stop the environmental degradation that is currently occurring.



Luis Lobster

As a member of the Arthropoda Party, I strongly believe in a fresh start. Everytime that I feel times are tight, I molt. Likewise, I feel that during these tight economic times I feel that we need to shed off our old ways and adopt some new changes to restart our economy.



Nellie Jellie

As a member of the Cnidaria Party, I have always been a strong supporter of security and defense. I believe in the right to bear arms, and routinely display my stinging firepower. This ocean can become a very dangerous place if we don't take security seriously.

Name: ______________________________ Date: ____________________

Invertebrate Election Worksheet

1. What party does Luis Lobster belong to? ____________________

2. What party does Nellie Jellie belong to? ____________________

3. Which candidate wants to expand the number of jobs in the ocean?

4. Which candidate supports the right to bear arms?

5. Which candidate is most likely to be against illegal dumping in the ocean?

6. Which candidate would favor more money going towards Oceanic Defense?

7. Which candidate is calling for economic changes?

8. What are other issues that you would like to see the candidate support?

Newberry: The Life and Times of a Maine Clam

Chapter 1

Once there was a clam named Newberry, who lived in a mudflat off the coast of Maine. Life on the whole was pleasant, except that the mudflat was rather chilly sometimes and rather damp most times. This suited Newberry until one particular morning in June when he woke up with a pain in his neck. As the days went on, the pain got worse and worse. Not only did it hurt, it almost cost him his life on one occasion. It happened this way.

Newberry's mudflat, being on the coast of Maine, was a rocky one. This was a good thing for him and his numerous cousins because people who dug for clams preferred nice, oozy mudflats without rocks. Rocks made for difficult digging, so Newberry lived a relatively safe existence.

Being a cautious soul, he lived under the edge of a particularly large granite boulder. When the tide was out he liked to stretch his neck out as far as it would stretch on the mud. He could stretch his neck a tremendous long way. He thought of the boulder as his boulder, although it did not any more belong to him than it did to the barnacles that lived on top of it.

Newberry enjoyed stretching his neck way out on the mud, because while the tide was out the sun warmed the mud, which eased the pain. It was risky business, however. One day a seagull stepped on his neck, and the pain was almost more than Newberry could bear.

But the way he almost lost his life was by day dreaming one sunny morning, when he should have been paying attention to the world around him. He was so busy dreaming that his neck went to sleep. Just at that time, an old rock crab happened by. He was a pretty old crab and his eyesight was a bit misty. Also, one eye had a bit of seaweed stuck to it. He saw Newberry's neck sticking out of the mud and thought it was something good to eat – he didn't know that Newberry was on the other end. So he snapped onto it with his big pincer claw, but since his eyesight was misty he nearly missed and didn't get a good grip on the neck. Newberry did not feel the crab at first because his neck was asleep, so he did not pull it in immediately. But the sharp pinch finally woke Newberry's neck and also woke up Newberry from his daydreaming. When he tried to pull in his neck the pain bothered him so much that he very nearly did not have the courage to yank, but yank he did. The crab was so surprised when his food yanked back that he let go. Newberry's neck came in so fast when the crab let go that he nearly gave himself a concussion. That was when he finally decided to see a doctor.

There was a doctor in the town of Blue Hill who had treated many kinds of odd patients. He had treated Freddy Byssal who cracked his ribs because he thought he could fly from the roof of his front porch. He had treated Old Man Wemble when he got his finger stuck in the hole he had drilled in the maple tree during maple sugar time. He had treated Jed Black after he had swallowed a mouth full of roofing nails when he slid off the top of Esau Gray's barn during a thick, slippery fog. He'd even untangled Old Stu Fletcher when he'd darned part of his long whiskers into a pair of socks he was trying to mend. But Newberry was the first clam he had ever been called upon to treat. He had eaten many clams but had never treated one. He didn't mention this to Newberry though, because he though it might be impolite. Besides he didn't want to believe that there was anyone or anything that he wasn't smart enough to cure.

"You have a crick in your neck," he told Newberry.

"I know that," said Newberry. "I want you to fix it."

"Well," said the doctor, "I'm not surprised that your neck ached since you spend all your time in a damp mud flat. What you need is a warm mud poultice to draw out the ache."

"I live in a warm mud poultice every time the tide goes out," said Newberry, "except during rainy weather. This has been an especially wet June.

"Yes," said the doctor, "the worst since 1967. Well, you cannot go around with a pain in your neck. It's quite a remarkably long neck, you know – quite the longest I've seen in my practice, and I've seen a great many necks. I must certainly report this to the Maine Medical Society. In the meantime, I'm going to prescribe some liniment. Rub it on twice a day or more if the pain gets too severe. If the neck is not better in a week, come back and see me."

Newberry went home to his boulder. Faithfully, twice each day, he rubbed liniment on his neck. It burned a little, but he figured any liniment with any healing power had to burn a little if it was any good. The liniment did not make the pain go away, but it did save Newberry's life.

It happened on the 4th of July, a particularly difficult day. Low tide came early in the afternoon. Several families had picnics on the shore that day. Children were scampering all over the place, so Newberry was constantly yanking his neck in to avoid getting stepped on. All this activity did not help the pain a bit. At one point one the grown-ups sat on the boulder while Newberry had his neck out. Newberry could not move enough to haul it in. He was stuck in that uncomfortable position for fully fifteen minutes. Fortunately, one of the children got into trouble, so the grown-up had to go rescue him. Soon as he could, Newberry put a double dose of liniment on his poor, aching neck. Later in the day when the picnickers left for Stonington to see the fireworks that would begin as soon as darkness fell, Newberry stretched his neck to get out the kinks, even though the tide had now come in and the water was cold.

But he hardly had it out and set in a comfortable position when a large, particularly hungry clamworm took a tremendous bite of it. How fortunate it was that Newberry had rubbed on a double dose of liniment. The liniment tasted so horrible and burned so fiercely that the clamworm let go instantly. He almost tied himself in a knot trying to get the taste out. Though the liniment saved Newberry's life, it did not make his neck feel the least bit better. When he could stand the pain no longer, he went back to the doctor in Blue Hill.

"You simply have to do something," he said.

"Well," replied the doctor, "I'm really not surprised that the liniment did not help, after all you insist on living in that damp mud flat. Medicine can only do so much. People who refuse to live sensibly, medicine cannot help them. Somehow we have to get that neck of yours warm and dry. I suggest that you go home and wrap a pure woolen muffler around it."

"What color woolen muffler?" asked Newberry.

"It really doesn't make much difference," replied the doctor, "as long as it is pure wool."

"I think purple is a pretty color," said Newberry.

"Purple is a very nice color," said the doctor.

"Won't it itch?" asked Newberry.

"By and by you'll get used to it," the doctor said.

"I suppose so," replied Newberry. Then he thought of something else. "Won't it shrink in the water? It could be very uncomfortable if it shrank while I had it tied around my neck."

"You needn't worry," said the doctor, "as long as you don't let it get into hot water. It would never do to let it get into hot chowder.

Of course it never did because not many people took the trouble to go clamming in rocky mud flats. Newberry became quite a celebrity in his mud flat. The pain in his neck finally went away, but the purple muffler made him look so distinguished that he decided to wear it forever afterwards. It still itches a bit at low tide, but he figures that it is worth it.

Chapter 2: Perils of a Purple Muffler

Newberry was very happy with his new purple muffler. It was an imported English muffler and one of the best. It not only kept his neck warm, it made him famous among all the animals who lived in the mud flat. At high tide when the water was deep and it was safe to stick his neck out, Newberry used to let the loose end of his muffler wave gently in the ocean currents like a piece of bright purple seaweed.

This wasn't always the wisest thing to do because sometimes a hungry tomcod or a small eel would snap at it, thinking it was good to eat. But now that his neck no longer had pain in it, he could snap it back in faster than any tomcod or eel could bite. Anyway, the tomcod and other fish were always so fascinated with the muffler that they aimed at it instead of Newberry's neck and missed him every time. There was not much to fear from crabs and lobsters because he was quicker than any of them. Sometimes a sea urchin would come and sit on the muffler, then Newberry would have a difficult time removing him because he held on tight with so many little suction feet.

At low tide, things were different. That was when Newberry should have kept his neck in the mud like any intelligent clam, but I am sorry to say that Newberry had become somewhat of a showoff. He would stick his neck out just far enough for the purple muffler to shine the brightest in the sun. One day a spotted sandpiper stopped to peck at it, but Newberry squirted him in the eye. The purple muffler got him out of trouble just about as often as it got him into trouble.

Once scary experience happened one morning when he was dug up by a man who was out clamming with his three children. Newberry had known they were coming by the vibrations in the mud. When the man's shadow fell on his neck, he yanked it down out of sight, but his quickness didn't help him this time. He felt the clam hoe crash through the mud behind him. The next minute, he and a few old neighbors were dredged into the open.

"Well, that's the end of me this time." He thought, "That man will surely see me with this bright muffler. How could he miss me? For once, I wish I were just like other clams, then I would be the same color as the mud and perhaps he wouldn't see me."

As the man began picking out the clams from the hoe full of mud, one of the boys shouting with great excitement, "Look Dad! There's a clam with a purple muffler!"

"Don't be ridiculous." Said the father. "Clams don't wear mufflers. Especially purple ones."

"This one does." Insisted the boy.

His two brothers came over to look. "He sure does!" they said.

Newberry had his neck in as far as it would go, but he never had been able to get it all the way in without having the muffler scrape off against his shells.

So there he lay, big as life with the muffler sticking out like a sign, saying "Here I am!" The father took his glasses out of his pocket so he could get a better look.

"Yes," he said at last "it certainly looks like a muffler." He thought hard for a moment. "I know! It must be a marker put on by a scientist studying clams. Let's throw him back, there are plenty of others."

"Ok." Said the boys, and one of them tossed Newberry back into the mud.

But Newberry had not learned his lesson.

The next morning, he stuck his neck out again. The tide was not all the way out, but it still was a dangerous thing to do. The water was cool, exactly the way he wanted it in the early morning. Cool water helped him wake up quickly after sleeping all night.

Well, there he was, wide awake, eating his usual breakfast of invisible animals that the tide swept past his burrow. This morning there was a good current. Besides bringing breakfast, it tugged at a lose thread at one corner of the muffler. The bright purple thread waved back and forth and wiggled, just like a worm, which is exactly what an old rock crab thought it was.

He reached out with his pincer and grabbed the lose thread. Of course, when he got the thread into his mouth he realized it was no worm. Naturally, he tried to spit it out. *Cough, cough, cough*. But fuzzy, woolen threads have a habit of sticking to things, especially things like spiny claws and crabs' mouths. When the rock crab discovered that he couldn't let go of the thread, he crawled off sideways and backwards, trying to pull free.

Ordinarily, this would have worked fine, but this time it didn't work at all, because as he backed away, the thread began to unravel from Newberry's muffler. In the meantime, the tide had run out all the way. What a sight there was when the whole mudflat came into view. There for everybody to see lay a long purple thread with an old rock crab at one end and Newberry at the other. The crab was trying desperately to get untangled from the thread while Newberry, with his neck stretched to the limit, was trying just as desperately to wind the thread back and around his neck before the muffler unraveled completely and disappeared.

While this was going on a herring gull, who had not had any luck at all in finding breakfast, glided over the mudflat. The first thing he saw was Newberry's neck. He landed a few feet away and walked over carefully to inspect this strange object. You must remember that he had never before seen a clam with a muffler, so he was being pretty cautious. When he arrived closer, he cocked his head to one side for a more careful look. Newberry was too busy trying to wind up the thread to notice the gull. When the gull saw the neck move, he decided that the strange object was good to eat. He grabbed the neck, yanked the surprised Newberry out of the mud and swallowed him, muffler, shell, and all in one mighty gulp.

It was hard to say who was more surprised: Newberry at finding himself in a herring gull's stomach, or the herring gull, at finding that he had swallowed a whole clam. If he had realized that the strange object was part of a clam he would have done what he always did. Instead of gulping it down, he would have held the clam in his beak, flown straight up into the air, and dropped it on the rocks below to smash it. Instead, here he was with a big, hard clam in his stomach.

The lump was so distressing, that he did not even notice that a purple thread hung out of the corner of his mouth. He felt pretty uncomfortable, so he threw back his head and made the most mournful herring gull cries ever to tell the whole world how uncomfortable he did feel. Another herring gull who was also out searching for breakfast heard the unhappy cries. She flew over to investigate. She glided over the mudflat and came down to land just a few feet away from the first gull. Before the first one could explain his trouble, the second one discovered the old crab that was still trying to untangle himself from the thread of Newberry's muffler.

In the twinkling of an eye, the old crab disappeared into the second herring gull's stomach. Seeing nothing else to eat, the second gull jumped into the air, flapping her wings, and began to fly out to sea. She had not gone more than three feet when something tugged at her mouth and jerked her back down to the mudflat. At the same time, the first gull, with Newberry inside, was also jerked off his feet. He fell facedown in the mud and his neat, white coat became covered with oozy, gray stuff.

The two gulls looked at each other. It took them only a minute to realize what was wrong—they were hitched together by the thread of the muffler! One end of the thread was attached to Newberry, who was in the first herring gull's stomach, while the other end was attached to the rock crab, who was in the second herring gull's stomach. Neither gull wanted to give up his breakfast. Then began the most ridiculous tug-of-war imaginable. For a while, it looked as if the thread would break and both gulls would keep their breakfasts.

Fortunately, for Newberry, the muffler had been woven from the finest wool, so the thread was exceedingly strong. First one gull, then the other, would try to fly away. Each time he would be hauled down, out of the air. This yanking and pulling was very upsetting on stomachs. It was also upsetting on old Newberry and the rock crab. Finally, the first herring gull could stand the strain no longer—no breakfast was worth this much trouble.

At the next yank, he opened his mouth wide. Newberry came flying out of his stomach, landing on the mud with a squashy plop. At the same time, the second gull succeeded in biting through her end of the thread and flew away with the poor old crab still in her stomach. Newberry was so happy at being free, that he wasted no time in burrowing out of sight in the mud. He did not even bother to rail in the loose end of thread. There would be plenty of time to take care of that later. Anyway, he planed to cut the extra thread lose on the sharp edge of his shells. His handsome purple muffler would be shorter than before, but it would be neater without the loose ends. And a great deal safer.

Chapter 3: The Two-Day Tug of War

When Newberry woke up on the Tuesday after the fourth of July he didn't dream that he was headed for trouble. The trouble really got started a week earlier, but Newberry didn't know that either.

It all started when Mort the lobsterman hauled up a trap near Newberry's island. Mort followed the same routine with every trap. First he picked out the good lobsters and crabs, then he threw overboard the lobsters that were too short. After that, he threw overboard the old bait that the seagulls were crying for and replaced it with fresh bait that smelled just as bad. The last thing he did before pushing the trap back into the ocean was to clear out the starfishes and sea urchins that clung to the slats. He threw them overboard, too.

Mort wasn't too careful with starfishes and sea urchins because he did like them. They messed up his traps, and also his boat. So many times the sea urchins got smashed like eggs and the starfishes lost a leg or two.

On this particular day, Mort accidentally cut off the leg of one of large starfish. The slippery, smelly mess of sea urchins, crushed sea urchins, sea urchins that were bald because all of their spines had rubbed off, whole starfishes, half starfishes, the starfish with the missing leg, and the leg itself splashed overboard. Everything sank helter-skelter to the bottom before the seagulls could snatch up even the smallest bit. Down on the bottom, crabs and fishes rushed about, fighting over the pieces and gobbling up every scrap. Even starfishes arrived. They didn't rush, but they got there in time to pick up a few crumbs. Some of these crumbs were sea urchin crumbs and starfish crumb.

Starfishes didn't mind eating their relatives. Even the starfish with the missing leg hobbled over to the feast. The next day he got an infection and died, but the leg—which had fallen into a crack in the rocks where nobody could fish it out—remained very healthy. A few days later, ocean currents carried the leg into Newberry's mudflat where it drifted around and soon began to get very hungry.

Now what can be worse than to be a healthy, hungry leg with no mouth and no stomach? The leg had no brain either, so it couldn't think about these things. But it could grow. And grow it did! It grew into a brand-new whole starfish, complete with mouth, stomach, and five little legs. The stomach was no bigger than the leg from which it had grown. Just the same, it had a huge appetite. It had an appetite bigger than itself.

At last, it could hunt for something to eat. What it liked best were clams and mussels. It really should have started with a small clam or mussel—one its own size. Instead, it tried to eat the first clam it found. The first clam was Newberry. Usually, Newberry remained safe down in his burrow. However, earlier that day a clam digger had dug up the mudflat so thoroughly that the high tide had washed Newberry and many of his neighbors out into the open.

The starfish found him before he had time to dig back down into the mud. As soon as Newberry noticed the starfish, he pulled in his neck and closed his shell as tight as a stuck door. But the starfish had a way of opening stuck doors, especially if they were clamshells. First, he climbed on top of Newberry, who could hear the little suction feet go squish and pop, like raindrops on a roof. Then he grabbed Newberry's left-hand shell with the suckers of two of his legs, and Newberry's right-hand shell with all the suckers on two more of his legs. He didn't quite know what to do with leg number five, which was neither on the right, nor on the left.

While he was trying to make up his mind—which never worked very fast anyway—a loose end of Newberry's purple muffler, which stuck out between the shells, got in the way and tickled the starfish. After a few tries, the starfish caught hold of the muffler to keep it out of the way. That stopped the tickling and gave him an idea as well. He would pull Newberry out of his shells by his muffler.

At first, nothing happened. A few threads came lose and drifted away. But as the starfish pulled and pulled, the knot in the muffler got tighter and tighter around Newberry's neck until Newberry began to choke. Now, when Newberry chokes, he squirts water out through his neck. That's exactly what he did this time. A mighty squirt caused the starfish to let go of the muffler and he almost lost his balance.

The starfish decided then to do things the right way—the way starfishes were supposed to do things. He would simply pull Newberry's shells apart. So began the great tug of war. The starfish pulled from the outside and Newberry pulled from the inside. Now, neither Newberry nor the starfish moved very fast, but they both were very stubborn. The great tug of war began on Tuesday morning. By Tuesday afternoon the two were still pulling and neither had gained an inch. They pulled all afternoon and all night. Wednesday morning came and they were still pulling. The starfish was pulling for his dinner; Newberry was pulling for his life. If this had been a full-grown starfish, this might have been the end of poor Newberry.

It was still nip and tuck because the starfish had to many little suckers on each leg that it could rest some while the others kept up the pull. Newberry had only two big muscles, and these were beginning to get a bit tired.

The old barnacle on a rock neat Newberry's burrow watched the struggle with great interest. "How are things going?" he asked Newberry.

But Newberry was much too busy for conversation. Only a grunt came out from inside his shell.

"I'll get him!" said the starfish.

"I didn't ask you!" replied the barnacle. "Why don't you young starfishes tackle clams your own age and respect your elders?"

"I'm not a young starfish," said the starfish. "I'm an old starfish."

"How can you be so old, when you're so small?"

"I grew from one of my legs."

"That's ridiculous," snapped the barnacle. "Nobody can grow from his own leg."

"Well I can, and I'm much too busy to try to explain it to anybody as dull as you!" the starfish replied impolitely.

That insult hurt the barnacle. It made him so angry that he snapped his shell shut and sulked. The two had been trading insults that they didn't see a small eel, no bigger than Newberry himself, that had swum over to watch the tug of war. At that point, the starfish had managed to pull Newberry's shells apart just a crack.

Now, most of us eat by putting food in our stomachs, but starfishes eat by putting their stomach in the food and digesting it inside out. As soon as the starfish discovered the small crack he turned his stomach inside out and dropped it into Newberry. This was too much for Newberry.

"No fair tickling," he grunted. "Keep your stomach to yourself." Just then, the tickling made him sneeze so hard that his shell snapped together and gave the starfish stomach a mighty pinch!

"Ouchhh!" cried the starfish as he pulled his stomach back where it belonged.

The eel had never seen anything so funny. He swam closer for a better look. But he came too close. He bumped into the rough coat of the starfish, which had a lot of little pincers. The pinch from the starfish caused the eel to wriggle and twist so that he almost tied himself in a knot. He tried to rub the itchy spot on the nearest thing at hand. The nearest thing was Newberry. He rubbed all over Newberry and rubbed off a lot of the slime that made him slippery as an eel. Everything became a slimy mess.

All of a sudden, the starfish began to slip in the slime. First one leg, then another, then all five at once. Waving wildly he slid off Newberry and tumbled slowly to the bottom. Before he could clean himself or get a hold on something—anything at all— a trickly current picked him up and tumbled him in big summersaults out to sea. At the last moment, he tried to grab a branch of seaweed to save himself, but a middle-sized fish, a cutter whose eyesight was not especially sharp, smelled the eel slime, thought that the starfish was a delicious young eel, and snapped him up in one gulp.

Back in the mudflat a very tired Newberry relaxed his muscles, pushed out his neck—which was very cramped—and gave a big sight of relief that ended up as a gurgle as he sucked in a huge gulp of cool water.

"That was a close one!" said the barnacle, who had gotten over his sulk.

"Much too close," agreed Newberry, and promptly went to sleep while his purple muffler waved gaily in the incoming tide.

Chapter 4: Newberry's Birthday Feast

August 14 was Newberry's birthday. He was five years old, which is pretty old for a clam. It was like being an old, old man, but Newberry didn't feel old and he wanted to celebrate his birthday.

How can anyone celebrate a birthday in a mudflat? He couldn't bake a cake, and even if there were, there was no way to light candles. Newberry decided instead that he would have a great banquet. He would eat and eat until he couldn't hold anymore. He would stuff himself as he had never stuffed himself before.

So when the tide started in, Newberry began to eat all the delicious tidbits that the currents brought to him. He didn't have to stir from his doorstep—the tide surging in from the flat brought in all sorts of special things.

There were the eggs of sea animals so small that he couldn't even see them. There were the tiny animals themselves. He sucked them all in. For this main course he ate little floating animals and larvae. For his salad, he stuffed himself with the tiniest of plants.

Before he quite realized what had happened, he stuffed himself so full there was hardly any room for him between the shells. Even his burrow was too tight. He pulled himself up near the entrance. He felt mighty uncomfortable. Then the trouble really began—he got terrible indigestion. A big bubble of gas formed in his stomach. Now it is bad enough to have a bubble of gas in one's stomach because it hurts, but in Newberry's case the trouble was worse. The bubble made him so light, that before he knew what was happening, he floated right up out of his burrow to the top of the water.

There was an offshore breeze that began to blow him out to sea. If bubble had not been so painful, Newberry might have enjoyed himself. He was a venturesome soul and liked to travel, but being a clam he never had much opportunity. Now here he was sailing grandly out to sea, his bright purple muffler trailing in his wake. What a stirring sight! What a pity that he was not really enjoying it.

Just as Newberry was rounding the edge on the east side of the mudflat he got caught in the riptide between the two islands. A great black-backed gull appeared at his starboard bow. This time it surely seemed that Newberry's end was in sight. The gull spotted him bobbing along on the tide. He was so conspicuous with the long end of his purple muffler trailing out behind, that any gull would have to be blind not to see it.

Fortunately for Newberry, Mort the lobsterman hove into sight at just his moment. Mort had eighty traps out, each one marked with a bright white and yellow buoy. In his boat he had a big barrel of pickled redfish for bait. As he hauled each trap in, he would take out the lobsters, throw back the short ones and the ones with eggs, then pick out the crabs—which he threw in the bucket—and lastly, take the old bait out of the bait bag and fling it overboard.

This was just what the great black-backed gull relished. He couldn't be bothered with one sick clam. He would do better to follow Mort's boat. So he wheeled away, leaving Newberry to bob safely, but helplessly before the wind. By two o'clock in the afternoon, he had drifted past the red buoy marking the channel into Blue Hill.

A cormorant sitting on top of a buoy with his wings stretched out to dry, looked down at him. "You're on the wrong side!" he said.

"What difference does it make whether I'm on my right side or my left side?" said Newberry, "one side hurts as much as the other."

"You're on the wrong side of the buoy!" said the cormorant. "Leaving the harbor, you're supposed to have the red buoy on the port side."

"Right now," said Newberry miserably, "I wish I were entering the harbor, instead of leaving it. What will become of me if I go out to sea?"

"Someone will probably eat you!" the cormorant replied. "But then I'm not so sure—you look silly with that purple muffler trailing out behind."

Newberry didn't hear the cormorant answer, because a puff of wind had blown him out of hearing. There's not telling how far out to sea he might have been blown if the great black-backed gull had not stopped following Mort's boat, because he was tired of eating old bait. He sailed around looking for something for dessert. That was when he spied Newberry. He swooped down and picked poor old Newberry neatly off the crest of a curly wave. Without missing a wingbeat, he turned back toward the island with the mudflat. He was searching for a rock on which to crack open his dessert. Finding one ledge that looked particularly nice, he hovered over it and opened his beak. Down went Newberry, his purple muffler flapping wildly as he fell. He was certain that his end had come, but instead of landing on the rock and smashing into a million pieces he landed on a big patch of seaweed. The seaweed was thick and slippery and full of little bladders of air, which acted as a cushion. Even so, he landed with a tremendous thump that almost knocked the bubble out of him.

His troubles were not over, however, because the gull had followed him all the way down. Before Newberry could even wonder where he was, the gull picked him up, flew straight up in the sky, took aim at a bare spot on the ledge and let go. Once more, Newberry tumbled toward the ground. The seagull's aim was pretty poor and again Newberry landed in seaweed.

I can't stand much more of this, he thought as his insides sloshed around after the tremendous bump. Three more times the gull dropped him; each time he missed the rock.

"Hmmm, I'll try once more," said the gull to himself. He picked up battered and bruised Newberry, flapped up, up, and up, took extra careful aim, and let go for the last time. Down tumbled Newberry, twisting and turning in the air until he was quite dizzy. When he was halfway down, a gust of wind stronger than the rest swept in from the bay. It capsized one of the racing sailboats, blew the cormorant off the buoy, flipped the seagull into a spin, and blew Newberry three degrees to the east! He landed on a big patch of seaweed at the very edge of the ledge, bounce once, and slid into the water.

The gull was disgusted. "Hmm, well," he said to himself. "He was probably tough. Besides, I really don't feel like having dessert. I think I'll fly over to the other side of the island and see what that family at the shore is eating at their picnic."

At last, Newberry was left alone to bob up and down in the waves. The waves were getting bigger. There were even a few small whitecaps. There was no doubt about it, the sea was getting rougher. Before long, Newberry became horrible seasick.

"What a day," he thought. "I've never felt so miserable. My stomach aches, my insides are all scrambled, my brain is bruised, and now I feel as though I'm going to lose my dinner."

He turned pea-green. He wasn't used to bobbing about on top of the water. Down on the bottom where he lived, the sea was always calm. The mudflat was a good, solid place. It never heaved up and down. He tried very hard to keep from getting sick. He tried to think of pleasant things. It was not use—his stomach just would not listen to his brain. It growled and grumbled and bubbled and boiled. He couldn't hold his dinner any longer.

Up came that wonderful birthday dinner—every last bit of it. At the same time, he felt a tremendous burp! Up came the bubble with the dinner. No sooner was the bubble out of Newberry than he lost all of his buoyancy. Without the big bubble inside of him, he no longer floated. Slowly, he began to sink. The sea became calmer. He slid smoothly toward the bottom and landed gently in the mud. The current of the tide tumbled him softly along and finally bumped him gently against his very own rock. With a great sigh of thankfulness, Newberry wasted no time in burrowing deep into the mud where he promptly went to sleep and didn't wake for three days and three nights.

Spineless Suspects

Goal:

- Students are able to extract relevant information about marine invertebrates from provided text.

Objectives:

- Students are able to correctly identify at least 3 invertebrates based upon their adaptations.
- Students are able to correctly identify at least 2 phyla based upon common characteristics.
- Students are able to name at least one invertebrate belonging to each phylum.

CA Standards:

Life Sciences:

3.3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

3.3.b. Students know examples of diverse life forms in different environments, such as ocean, deserts, tundra, forests, grasslands, and wetlands.

Reading:

3.2.6 Extract appropriate and significant information from the text, including problems and solutions.

Listening and Speaking

3.1.3. Respond to questions with appropriate elaboration.

National Standards:

Science

NS.K-4.1 Science as Inquiry

NS.K-4.3 Life Sciences

Materials:

- White Paper- 1 per student
- Markers
- Spineless Suspects Ads: Teacher's Copy (provided)
- Student Invertebrate Guide – one for every 2 students (provided)
- Ocean Discovery Investigators – one for every 2 students (provided)
- Classification Example: Humans (provided)

Setup:

- Make copies of "Student Invertebrate Guide" and "Ocean Discovery Investigators" (one for every 2 students).
- Have enough blank, white pieces of paper for every student to get one.

Procedure:

Introduction (15 minutes)

- Tell the students that today they will be learning how different marine invertebrates are classified. Classification is the arrangement of different species into groups based upon their similarities. Scientists begin looking at broad similarities, like having a group of all animals or having a group of all plants. Slowly, scientists then begin looking at more specific details, like having a group of all animals without backbones). The first step in classifying something is figuring out which Kingdom it belongs to. All invertebrates are animals – so they all belong to the Animal Kingdom.
- To demonstrate, show the students the Classification Example of Humans. Start with the Animal Kingdom - all the species pictured are animals. Then at the next level, Phylum, note that the sea star is no longer pictured. This is because all the animals pictured are chordates (animals with backbones), but the sea star is not a chordate (it is an invertebrate). Briefly cover each step of classification down to Genus and species.
- The next step of classification is called Phylum (plural form is phyla). Today we will be learning about the different phyla that marine invertebrates belong to. Remind students that all the phyla you are going to talk about are in the animal kingdom.
- Animals are grouped together into a phylum because they have similar adaptations. Ask students to recall what an adaptation is from their Ocean Science Explorers lesson. Adaptations are things that help animals and plants to survive in their environment.
- Explain to the students that today they will learn which phyla many of the organisms they have studied with Ocean Science Explorers belong to.
- Hand out the Student Invertebrate Guides to all students and briefly read through the different marine invertebrate phyla and some of their various adaptations. These adaptations are not necessarily found in every phylum member, but are overall characteristics.
    - Phylum Cnidaria:
        - tentacles (used to grab food)
        - stingers on tentacles (used for protection)
        - jelly filled bodies
        - Examples: coral, jellies and sea anemones
    - Phylum Mollusca:
        - shell (used for protection)
        - muscular foot (used to attach to rocks and move)
        - soft body (grows the shell and protects the insides)
        - Examples: mussels, snails, limpet, navanax, sea hare, octopus, squid, and keyhole limpet.
    - Phylum Arthropoda:
        - exoskeleton (used for protection)
        - claws (used to grab food and for protection)
        - jointed legs (helps them to move)
        - Examples: crab, hermit crab, barnacles, lobster
    - Phylum Echinodermata:
        - spiny skin (used for protection)
        - tube feet (used to attach to rocks and move)
        - regeneration (grow back body parts)
        - Examples: sea star, sea urchin, sea cucumber

Main Activity (40 minutes)

- Have students form pairs.
- Explain to the students that they are going to be Invertebrate Detectives today and solve some crimes using their knowledge of rocky seashore organisms. Each group is going to determine the identity of five suspects (down to the specific organism – e.g. Hermit crab, Squid) based on the clues given to them in the crime reports.
- Even though several organisms may fit a single description, each organism can only be used once, so it is important to go through all the ads first. Remember each invertebrate can only be used once!
- Pass out the "Ocean Science Investigators" worksheet to each student pair. Tell the students that you will read recently filed police reports (the various paragraphs from Spineless Suspects Ads: Teacher's Copy). After you have read the individual report at least twice, the students will be given time to write down what they believe are the relevant clues that will help them determine the identity of the perpetrator. If they appear stumped provide encouraging hints.
- As a class start with the example provided at the top of the Spineless Suspects Ads: Wanted for Stabbing. Read it out loud at least twice. Ask the students what they think are the important facts in the case and have them write them in the example on the worksheet Reveal the pertinent clues on the whiteboard - lots of long pointy spines and purple color.
- Based on their knowledge of invertebrates and the Student Invertebrate Guide have students tell you which invertebrate they think may have committed the crime and why.
- Reveal the correct answer.
- Continue reading the Suspect Ads one at a time. After the students have written down the clues, have the student pairs work together to determine who they think is the most likely suspect.
- After all clues and potential suspects have been written on the "Ocean Discovery Investigators" worksheet go over the answers aloud to make sure students have correctly identified the suspects.
- Now tell the students that they will have the opportunity to make a "Wanted Poster" for one of the suspects. Explain that each student will design his or her own Invertebrate Wanted poster for one of the suspects they just identified on a separate piece of paper. An example has been provided. Show students the example and go through what each poster should include:
    - A realistic portrayal of the invertebrate, with emphasis upon their defining adaptations. If they wish, the students can "outfit" the animal with clothes, props, etc. to match the crime.
    - A description of the invertebrate (as provided), including phyla.
    - A general description of the alleged "crime".
- This project can be repeated for another invertebrate if time permits.

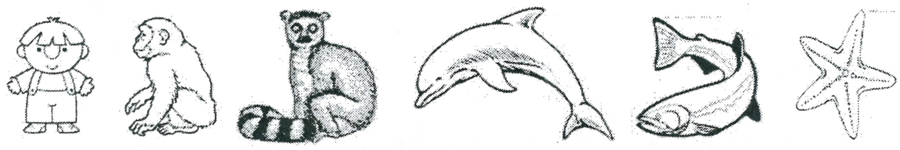
Closing (10 minutes)

- After students have completed their Wanted Posters have them form groups based upon which animals they did (so the hermit crabs get with the hermit crabs, the octopi with the octopi, etc.). Tell the students that scientists classify these animals together because they are the same species.

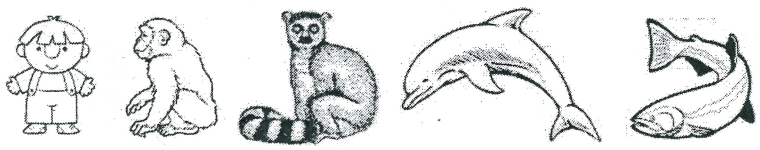
- Next have the students look around and see if there are any two groups that could join together because they have similar characteristics. Hint: let them use their Invertebrate Study Guide. The hermit crabs and the shore crabs can join together because they are both Arthropods and have similar characteristics (jointed appendages, claws). Also, the urchin and the sea star can join together because they are both Echinoderms and share similar characteristics (spiny skin, tube feet).
- Finally have students briefly share and explain their Wanted Posters.

Classification Example: Humans

Kingdom: Animal

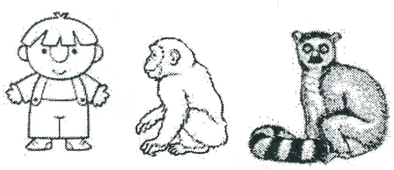


Phylum: Chordates

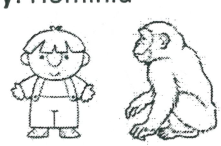


Class: Mammals

Order: Primates

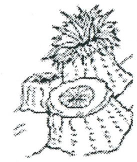


Family: Hominid



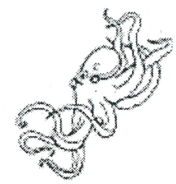
Genus and species: *Homo sapiens*

Student Invertebrate Guide



Phylum Cnidaria

- Tentacles with stinging cells
- Jelly filled bodies
  - ➢ **Jellies** – float around in water; capture prey with stinging tentacles
  - ➢ **Sea Anemones** – live in rocky seashores and are attached to the ground; capture prey with stinging tentacles; cover themselves with shells and rocks for protection
  - ➢ **Coral** – animal that lives in a colony and builds reefs

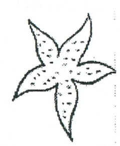


Phylum Mollusca

- Muscular foot
- Hard shells
- Soft bodies
  - ➢ **Sea Hare** – no shell; slug-like; shoots out purple mucus as protection to scare away predators
  - ➢ **Navanax** – no shell; make large amounts of slime as protection against predators
  - ➢ **Octopus** – no shell, have eight arms with suckers; the smartest of all invertebrates
  - ➢ **Bivalves** – this is a group of animals with 2 shells paired together like mussels, clams, oysters and scallops
  - ➢ **Gastropods** – this is a group of animals that has 1 shell like snails and limpets

Phylum Arthropoda

- Exoskeleton (hard covering over the body)
- Claws
- Jointed appendages (arms and legs that move)
  - ➢ **Lobsters and Crabs** – large claws used for protection or to get prey
  - ➢ **Hermit Crabs** – use empty shells for protection, move to new shells as they grow
  - ➢ **Barnacles** – cement their head to the rocks and use their feet to eat



Phylum Echinodermata

- Spiny skin
- Tube feet
- Regeneration (can grow back body parts)
  - ➢ **Sea stars** – five arms; bottom of arms have suction-cups called tube feet; turns stomach inside out to eat other invertebrates (stomach comes out of their body!)
  - ➢ **Sea urchin** – long, pointy spines; round body; California urchins are red, purple and black
  - ➢ **Sea cucumber** – long body; spits out its guts to scare away predators

Spineless Suspects Ads:Teacher's Copy

****** EXAMPLE: WANTED FOR STABBING ******

DEL MAR - A local surfer was sent to the hospital Sunday morning complaining of pains in his foot. Hospital officials determined that the man was stabbed repeatedly in the foot by several long, pointy spines. The victim claims he noticed several purple shadows in the water prior to the injury. He is currently being held at Scripps Hospital for observation.

Answer: Sea Urchin

1. **WANTED FOR BREAKING AND ENTERING**

BLACK'S BEACH – An invertebrate was caught attempting to break into the home of a local mussel. The mussel said the intruder must have been incredibly strong since the there was really tight security around the property. When police arrived at the seen they found a piece of an arm with tube feet attached and witnessed confirmed seeing the suspect running away on its four remaining arms.

Answer: Sea Star

2. **WANTED FOR STINGING**

LA JOLLA COVE – Stinging charges have recently been filed against an invertebrate with tentacles. The victim, a rocky seashore fish, said he was swimming through the area, minding his own business when he received a sharp sting on his fin. The suspect is through to be in hiding during low tides, possibly wearing a disguise of shell and rock pieces.

Answer: Sea Anemone

3. **WANTED FOR ROBBERY**

SCRIPPS – A masked invertebrate robbed the house of a local Mollusk on Wednesday night. The house, whose owner recently had died, was left vacant for several days before it was stolen. Authorities emphasized that this crime was unusual saying that, "the robber just entered and walked out with the whole house!"

Answer: Hermit Crab

4. **WANTED FOR GRAFFITI**

MISSION BEACH – A sneaky invertebrate was crawling around the tidepool on its numerous arms, using dark ink to graffiti the rocks and water. When authorities approached the criminal it emitted a huge cloud of dark ink that took minutes to go away. Once the water had cleared the invertebrate was nowhere to be found.

Answer: Octopus

5. **WANTED FOR LITTERING**

IMPERIAL BEACH – An All Points Bulletin has been put out for an invertebrate seen fleeing the scene after a littering event. The animal was seen slipping out of its former exoskeleton and then leaving the debris on the beach. When approached about cleaning up the mess the suspect scurried off sideways and hid under a rock.

Answer: Shore Crab

Ocean Discovery Investigators

Detectives: ____________________

____

Date: ____________________

EXAMPLE: WANTED FOR STABBING

DEL MAR –

- ____________________
- ____________________

ANSWER: ____________________

1. **WANTED FOR BREAKING AND ENTERING**

BLACK'S BEACH –

- ____________________
- ____________________

ANSWER: ____________________

2. **WANTED FOR STINGING**

LA JOLLA –

- ____________________
- ____________________

ANSWER: ____________________

3. **WANTED FOR ROBBERY**

SCRIPPS –

- ______________________________
- ______________________________

ANSWER: ______________________________

4. **WANTED FOR GRAFFITI**

MISSION BEACH –

- ______________________________
- ______________________________
- ______________________________

ANSWER: ______________________________

5. **WANTED FOR LITTERING**

IMPERIAL BEACH –

- ______________________________
- ______________________________

ANSWER: ______________________________

5a

Invertebrate Fractions

Goal:
- Students are able to develop fluency with the addition and subtraction of fractions.

Objectives:
- Students are able to turn visual representations into fractions and complete one-digit addition and subtraction.

CA Standards:

Math: Number Sense

3.3.1. Compare fractions represented by drawings or concrete materials to show equivalency and to add and subtract simple fractions in context.

3.3.2. Add and subtract simple fractions

3.3.4. Know and understand that fractions and decimals are two different representations of the same concept.

Materials:
- Invertebrate Fractions worksheet
- Pencils

Setup:
- Make one copy of Invertebrate Fractions worksheet for each student

Procedure:

Introduction (20 minutes)
- Inform the students that today we will be working with fractions. If they are unfamiliar with fractions, explain that it is number quantity that is not a whole number. They encounter fractions anytime they eat pie, pizza or cake. The pizza begins as a whole, but then each time a slice is removed a fraction of the pizza is removed. If ¼ of the pizza is removed, ¾ remains. If another ¼ is removed from the pizza, only ½ remains. And so on.
- Tell the students that invertebrates provide good practice for fractions, since they have so many different appendages. Tell them that an appendage is a body part that sticks out from the main part of the body; our arms and legs are appendages. Ask how many appendages a sea star usually has. *Answer: five.* Ask how many appendages an octopus usually has. *Answer: eight.* Ask how many appendages a squid has. *Answer: ten.*
- Draw a sea star with five arms on the board. Ask the students how many arms it has. Write 5/5 on the board and explain that this sea star has all five of its five legs. Explain that the 5 on the bottom represents how many arms a complete sea star should have and that the 5 on the top represents how many arms this sea star currently has. Remind them 5/5 is equal to the whole number 1. So this sea star is a whole sea star.
- Next tell the students that a fishermen cut off two of the sea stars arms (in the past this was common practice for oyster fishermen, because they though it would kill the animal). Erase two of the sea star's arms on the board. Ask the students what fraction of arms it has remaining. Write 3/5 on the board and explain it to the students. Remind the students

that the top number is the number of actual arms it has now and that the bottom number is how many it should have. The sea star should have five arms, but only has 3 so it is 3/5 complete.

- Now explain that sea stars have the amazing ability to regenerate lost appendages. How many arms would the sea star need to regenerate to become complete? *Answer: two.* Write the numerical representation on the board 3/5 + 2/5 = 5/5. If not previously covered, discuss addition of fractions.
- Repeat this exercise for a crab. Draw a crab on the board that has 10 appendages. Ask the students how many appendages it has. Write 10/10 on the board, again explaining that this crab is a whole number since it has a complete number of appendages.
- Next tell the students that a sea gull came and ate three of the crab's appendages. Erase three of the appendages on board. Ask the students what fraction of appendages it has remaining. Write 7/10 on the board and explain it to the students. The crab should have 10 appendages, but only has 7 so it is 7/10 complete.
- Now explain that crabs periodically molt (which means to shed their tough exoskeleton). When they do, they can re-grow lost appendages. How many appendages would the crab need to re-grow to become complete? *Answer: three.* Write the numerical representation on the board 7/10 + 3/10 = 10/10. If not previously covered, discuss subtraction of fractions.
- If you would like you can do a few more example on the board and explain about reducing fractions to their lowest common denominator.

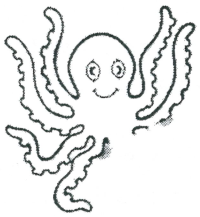
Main Activity (30 minutes)

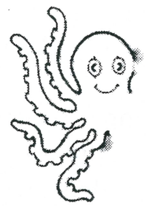
- Pass out the Invertebrate Fractions worksheet to the students. Tell they are now going to work independently to determine the fractions of different invertebrates. They will also be adding and subtracting different appendages from these different invertebrates.

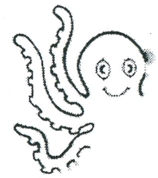
Name:________________________________ Date:____________________

Invertebrate Fractions

What fraction do each of these invertebrates represent? *Hint: octopi usually have 8 arms.*

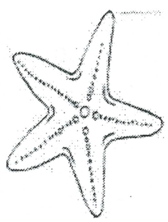
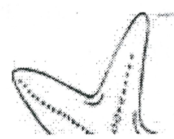






______________ ______________ ______________

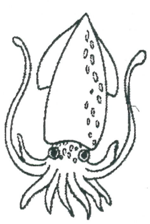
Under each picture, write what fraction is represented. Then, either add or subtract the following invertebrate parts as indicated. Don't forget to reduce.

 −  = ______________

________ ________

 +  = ______________

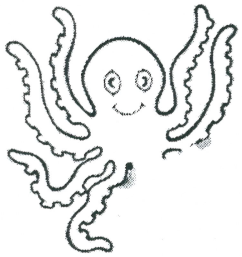
________ ________

 − *Hint: Squid usually have 10 appendages*  = ______________

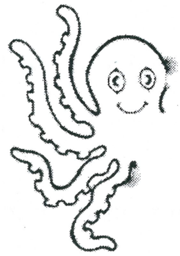
________ ________

Invertebrate Fractions

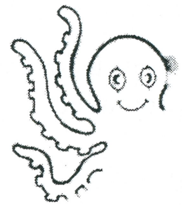
What fraction do each of these invertebrates represent? *Hint: octopi usually have 8 arms.*



_______6/8 = 3/4_______

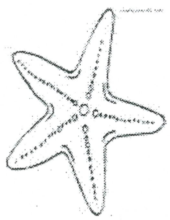
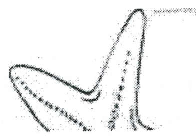


_______4/8=1/2______

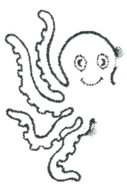


_______3/8________

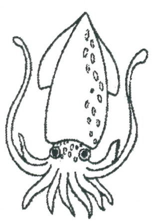
Under each picture, write what fraction is represented. Then, either add or subtract the following invertebrate parts as indicated. Don't forget to reduce.

 −  = 3/5

5/5   2/5

 +  = 7/8

4/8=1/2   3/8

 − *Hint: Squid usually have 10 appendages*  = 4/10 = 2/5

10/10   6/10= 3/5

Newberry, the Life and Times of a Maine Clam

Goal:

- Students learn about the complex food web that exists in the marine environment.

Objectives:

- Students are able to list at least three organisms that feed on clams in the rocky seashore.
- Students are able to list at least one thing that a clam feeds on in the rocky seashore.

CA Standards:

Reading

3.2.6. Extract appropriate and significant information from the text, including problems and solutions.

Science

3.3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

3.3.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

3.3.c. Students know that living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

National Standards:

Science

NS.K-4.1 Science as Inquiry
NS.K-4.3 Life Science

Materials:

- Newberry: the Life and Times of a Maine Clam (provided)
- Large piece of white paper
- Markers

Setup:

- Have large piece of white paper set up at the front of class.
- If you want the students to follow along or to take turns reading aloud, make copies of Newberry: The Life and Times of a Maine Clam.

Procedure:

Introduction (10 minutes)

- Ask students where the invertebrates that they have been studying come from. *Answer: the rocky seashore*. Next ask the students if they think that California is the only state with a rocky seashore. *Answer: no.*
- Tell the students that they are going to learn about an invertebrate from a rocky seashore in Maine by reading portions of a story called <u>Newberry, the Life and Times of a Maine Clam.</u>
- Remind the class, that the rocky seashore is a difficult environment. Ask students what kinds of factors make life at the rocky seashore hard. *Potential answers include: water, sunlight, salt, waves, wind, predators, etc.*
- Tell the students that as they follow the adventures of Newberry they should try and remember some of the organisms that Newberry eats and that try to eat him.

Main Activity (35 minutes)

- Over the course a few days read chapters from Newberry, the Life and Times of a Maine Clam, reminding students to listen for examples of predation.
- After completing the book, tell the students that they are going to make a food web.
- If students are unfamiliar with what a food web is, inform them that it is a web that connects animals through what they eat or what eats them in a particular ecosystem. If one animal eats another animal, an arrow is drawn from the prey to the predator.
- A food web is an important way to show how interconnected nature is and how everything relies on something else for survival.
- One the white piece of paper, draw a picture of Newberry in the center.
- Next, ask the students it they can recall what Newberry eats, reminding them that Newberry is a filter feeder. Answer: microscopic plankton. So draw a clump of specks to represent plankton. Then draw an arrow from the plankton to Newberry, since he eats them.
- Next, ask the students if they can recall some of the animals that tried to eat Newberry. Below are some sample answers:
    - Crab. The misty-eyed crab tried to eat Newberry. Draw the crab and then draw an arrow from Newberry to the crab.
    - Clamworm. The clamworm grabbed onto Newberry's neck when it was covered with liniment, but it tasted so bad he let go. Draw the clamworm (essentially looks like a big worm) and then draw an arrow from Newberry to the clamworm. Crabs like to eat clamworms, so draw an arrow from the clamworm to the crab.
    - Tomcod. The tomcods would aim for Newberry, but mainly got the purple muffler. Draw the tomcod (a type of fish resembling a small cod) and then draw an arrow from Newberry to the tomcod.
    - Herring gull. This gull tries to eat Newberry when he is attached to the rock crab. Draw the bird and then draw an arrow from Newberry to the

gull. Also, the herring gull tries to eat the crab at the other end. Draw an arrow from the crab to the herring gull.

- Great black-backed gull. This gull tries to pick up Newberry and drop him on the rocks. Draw the seagull and then draw an arrow from Newberry to the seagull. Remind the students that the seagull also tried to eat a crab, so draw another arrow from the crab to the seagull.
- Sea star. The sea star thrown from the lobsterman's trap tried to pry open Newberry's shell. Draw the sea star and then draw an arrow from Newberry to the sea star.
- Cunner. This is another fish resembling a wrasse. This one ate the sea star after the tug of war with Newberry. Draw the cunner and then draw an arrow from the sea star to the cutter. The cunner is also good food for tomcod, so draw and arrow from the cunner to the tomcod.
- Humans. The family that was out digging for clams found Newberry, but though he was part of a science experiment. Draw a human and then draw an arrow from Newberry to the human. Humans like to eat crabs, so draw another arrow from the crab to the human. Humans also like to eat tomcod, so draw an arrow from the tomcod to the human.

Conclusion (10 minutes)

- Tell the students that certain animals play a very important part in the food web. If they were removed, then the entire ecosystem could die.
- Demonstrate this to students by covering up Newberry on the paper. Ask the students what would happen if Newberry (and all other Maine clams) were removed from the ecosystem. *Answer: All the animals that relied on clams for food would be in trouble and could potentially die off.*
- While Newberry is really important for the entire ecosystem, ask the students if there is an even more important organism in the food web – an organism that if it were removed the entire ecosystem would collapse. Give them a few moments to look. *Answer: the plankton.*
- Tell the students that if plankton, which forms the base of the food chain, were to disappear then the clams, crabs, fish, etc. that at the plankton would die. And then all those animals that relied on those animals for food would die – which is every animal in the food web.
- Emphasis how interconnected all of these animals are in the food web.

Dichotomous Key (Day 1)

Goal:

- Students are able to learn how to use a dichotomous key and through that become familiar with different invertebrate characteristics.

Objectives:

- Students are able to successfully identify at least two marine invertebrates by using the dichotomous key.
- Students are able to explain at least one tool used by scientists to classify organisms.

CA Standards:

Life Sciences:

3.3.a. Students know plants and animals have structures that serve different functions in growth, survival and reproduction

3.3.b. Students know examples of diverse life forms in different environments, such as ocean, deserts, tundra, forests, grasslands and wetlands.

National Standards:

Science

NS. K-4.1 Science as Inquiry

NS. K-4.3 Life Science

Materials:

- Laminated invertebrate pictures
- Dichotomous Key Handout (1 per 2 students)
- Student Invertebrate Guide (1 per 2 students) – from Spineless Suspects Lesson
- Tupperware containers

Setup:

- Make copies of Student Invertebrate Guide and Dichotomous Key

Procedure:

Introduction (20 minutes)

- *If haven't completed Spineless Suspects activity, review this information, including the Classification Example: Humans.* Explain that all organisms are grouped together based upon their similarities. Emphasis that the people are also grouped based upon their own similarities; they live in families who have similar hair color, noses, smiles, etc.
- The animals are organized into groups that are called Phyla (phyla-plural, phylum-singular). Animals in each phylum have adaptations that are similar, but not identical.
- Explain that each student is going to get the chance to be a scientist today and learn to group animals using a dichotomous key (fancy word for a tool used by scientists). Explain that a dichotomous key is an easy way to classify animals based on what they look like.

- Dichotomous keys start with a question about the organism you are looking at. The question can be answered either yes or no. Based on whether the answer to the question is yes or no, the reader will be directed to another yes or no question or will be directed to the name of the identified organism. When you use a dichotomous key to identify an organism you may have to answer only one question or you may have to answer ten, but you continue answering questions until one answer leads you to the name of an organism.
- Explain that you will use a dichotomous key together as a group to identify something
- Put a picture of Bart Simpson on the overhead (http://www.dctobc.com/wp-content/uploads/2009/03/bartsimpson4.gif) or use a picture found on the internet. Tell the students that even if they recognize who this character is, they are going to use the following dichotomous key to determine what it is.
- Now put the cartoon sample dichotomous key on the overhead. Go through each step with the students. Start with the question at the top, then follow the arrow to either the next question or the name of the character.
- If you would like to repeat the process, choose another character, either: Minnie Mouse, Tigger or Spongebob and get their image from the internet.

Main Activity (15 minutes)

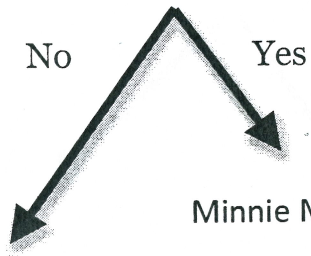
- Now have the students form pairs – each pair should receive a dichotomous key.
- Tell the students that now they are going to work in pairs using their own dichotomous key to identify real marine organisms.
- Pass out the dichotomous key to each student pair and ask if there are any questions about vocabulary or how to use the key.
- Next pass out the pictures (octopus, hermit crab, sea star and sea anemone) randomly to student pairs. By looking at the pictures and following the directions on the key, have kids determine what invertebrate they are looking at.
- Let them try out the dichotomous key with several of the different pictures to gain familiarity.

Conclusion (25 minutes)

- Tell the students that they will soon get the opportunity to write their own dichotomous key, but in order to do so they will need to go on a collection expedition.
- Remind students that invertebrates don't just live at the rocky seashore, they live in all kinds of habitats. Tell the students that they need to go outside to the nearest garden, canyon, playground, etc. and collect some insects and other bugs. Remind them what invertebrates are so that they don't try to use birds, amphibians, mammals, etc.
- Have the students form groups of four. Hand each group some Tupperware containers and tell them to collect at least four different invertebrates.
- When outside, spend some time exploring the invertebrates located around them. Try to point out some of the obvious differences: number of legs, the presence or absence of wings, size, appearance, etc.
- At the end, bring the invertebrates back to the classroom with some leaf litter for habitat. Keep them overnight for part II of the dichotomous key activity.

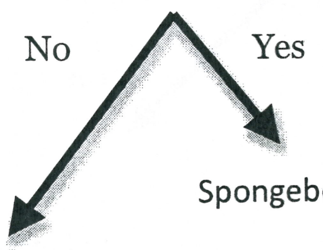
Sample Cartoon Dichotomous Key

1) Is your cartoon character female?



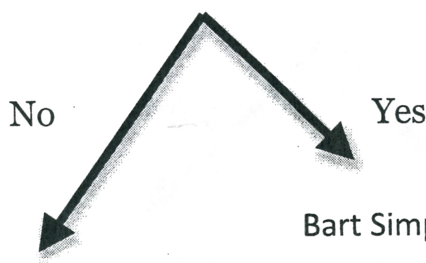
Minnie Mouse

2) Does your cartoon character live in the ocean?



Spongebob Squarepants

3) Does your character have yellow, spiky hair?



Bart Simpson

Tigger

<u>**Dichotomous Key**</u>

1) Does your invertebrate have a strong, hard shell that it carries around with it?

No

Yes

Hermit Crab (Arthropoda)

2) Does your animal have 5 arms?

No

Yes

Sea Star (Echinodermata)

3) Does your animal have 8 tentacles?

No

Yes

Octopus (Mollusca)

4) Does your animal look like an undersea flower?

Sea Anemone (Cnidaria)

Dichotomous Key (Day 2)

Goal:
- Students become familiar with different invertebrate characteristics and the scientific technique of distinguishing between organisms as they create their own dichotomous key.

Objectives:
- Students are able to construct a usable dichotomous key based upon at least 3 different characteristics between terrestrial invertebrates.

CA Standards:
Life Sciences:
- 3.3.a. Students know plants and animals have structures that serve different functions in growth, survival and reproduction.
- 3.3.b. Students know examples of diverse life forms in different environments, such as ocean, deserts, tundra, forests, grasslands and wetlands.

National Standards:
Science
- NS. K-4.1 Science as Inquiry
- NS. K-4.3 Life Science

Materials:
- Insect/Spider identification books (Golden Guides are great for this)
- White paper
- Pencils or markers
- Collected invertebrates (from previous day)

Setup:
- Have enough paper and pencils/markers for each student.
- Prepare students to go outside in the canyon for today's assignment.
- Divide up the invertebrates collected the previous day for various groups.

Procedure:
Introduction (10 minutes)
- Now that the students have experience working with a dichotomous key, they will have the opportunity to create their own.
- Remind students that the intertidal zone is not the only place that invertebrates live. They can be found in most habitats: forests, deserts, houses, even the canyons near their schools.
- Tell the students that they will get to make their own dichotomous key, but they are going to use the invertebrates that they collected yesterday in their local canyon or schoolyard.

Main Activity (40 minutes)

- Have the students form pairs and work in a similar area. Each student will spend about 15-20 minutes preparing their own dichotomous key, based upon the invertebrates morphology. When both students in the pair are finished they will switch keys with their partner. They will use their partner's dichotomous key to see if they can correctly identify the animal.

Closing (10 minutes)

- Remind the students that they were all scientists for the last hour, doing the same work scientists are trying to do right now.
- Have students talk about what it was like making their own dichotomous keys. What were some of the more helpful clues? What clues were less successful?
- Have the students try and imagine how difficult it would be to try and make a dichotomous key for all living organisms, which is a couple million and counting.

Invert Infants

Goal:
- Students are able to understand that many organisms, including marine invertebrates, have various life stages where they do not resemble their adult form.

Objectives:
- Students are able to name at least two stages of the butterfly life cycle
- Students are able to list at least three invertebrates that have a unique larval stage.

CA Standards:
Science
- 3.3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.
- 3.3.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

National Standards:
Science
NS.K-4.3 Life Sciences

Materials:
- Butterfly Life Cycle Image
  http://www.kingstonfieldnaturalists.org/bluebill/images/butterfly_lifecycle.jpg
- Invert Infants Handout
- Crab Life Cycle Image
  http://nio.org/crab/crabs/life1.gif
- Pencils

Set-up:
- Make a copy of the Invert Infants Handout for every student

Procedure:
Introduction (15 minutes)
- Tell the students that today they are going to learn about the life cycles of some marine invertebrates that they have seen. Ask the students if humans go through different life stages and if so what they are. *Answers may vary, but something to the effect of baby, child, adolescent and adult.*
- Ask the students if those human life stages look similar or different. They can be prompted with questions such as: Do you eat the same foods you ate when you were a baby? Are you the same size now as you will be when you are an adult? Do you move the same way? There will be similarities and differences (presence or absence of hair, height, weight, mobility, food choices, etc.)
- Next ask the students if they have ever seen an invertebrates undergo different life stages. One example of an invertebrate with different life stages is a butterfly. At a very young age, butterflies are caterpillars, they crawl around and don't have wings. They also eat a lot of leaves

in order to plump up before building a cocoon. Ask the students why the butterfly would need to eat so much before the build the cocoon. *Answer: To have energy to survive during the chrysalis period.*

- Ask students if they know how a butterfly changes from a caterpillar into the final butterfly stage. *Answer: it undergoes a metamorphosis*. When the butterfly emerges from its cocoon it is an adult butterfly and will not undergo any more changes.
- Show the students the visual representation of the life cycle of a butterfly. http://www.kingstonfieldnaturalists.org/bluebill/images/butterfly_lifecycle.jpg
- Butterflies and moths are not the only animals that undergo significant changes during their life. In fact a lot of marine invertebrates that the students have been studying with Ocean Discovery Institute undergo changes, they just happen in the ocean so we don't see them.

Main Activity (30 minutes)

- Tell the students that now they are going to look at the life stages of some of the marine invertebrates they have been studying with Ocean Discovery Institute. Handout the Invert Infants Worksheet to each student. Tell them that each picture represents the larval stage for an invertebrate. Explain that the larval stage is like the baby or child stage for a human and that like humans these larval invertebrates will look much different when they are adults.
- Tell the students to look carefully at the pictures to see if they provide any clues as to what the invertebrate will look like as an adult. Tell the students that some of the larval stages do not look like the adult stages, so clues have been provided below the picture to help the students distinguish who is who.
- Have the students answer the questions of their worksheet to the best of their ability. If they are really stumped have them refer to the Invertebrate Study Guide provided in the previous Spineless Suspects activity.

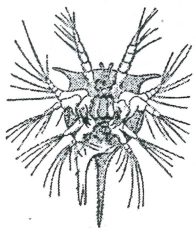
Closing (10 minutes)

- Go over the answers together as a class and discuss the clues that should have tipped them off as to the identity of each invertebrate.
- Remind students that many invertebrates go through life cycle changes and do not always resemble their adult forms. Ask students to name the phases of a butterfly's life cycle
- Ask students to name a few of the marine invertebrates they looked at today which have larval forms that do not resemble their adult forms.
- Finally pull up the Crab Life Cycle image from the website provided (http://nio.org/crab/crabs/life1.gif). Have the students examine the cycle and look to find similarities and differences between the crab and butterfly life cycles.

Name: ______________________________ Date: ____________________

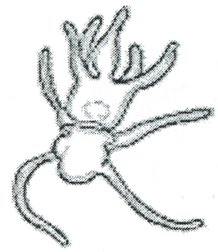
Invert Infants

Like butterflies, marine invertebrates undergo life cycle changes in the ocean. They may start out life looking very different from their adult form. Use the pictures and the clues below each to figure out what these rocky seashore invertebrates will look like when they grow up.



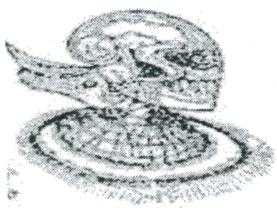
While I float around in the ocean now, when I grow up I will cement my head to a rock and start to use my feet for feeding.

____



I have a lot of appendages now, but when I get older I will only have 5 arms. Unless, I lose one, and in that case I will just grow it back.

____



I may look strange now, showing all these soft body parts, but when I grow up all this will fit inside a nice two-part shell.

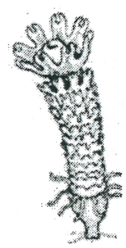
____

My flat body will plump and become pickle-lie as I grow up. I will also develop a new trick when I get stressed – I will spit out my guts.

____

This may be a weird look right now, but come back in a few weeks when I'm covered by an exoskeleton and develop two claws for pinching.

____

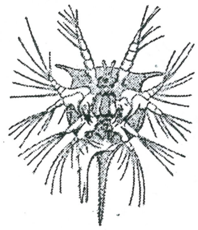


In this stage of my life, I may look like I'll live attached to the seafloor, but I will soon swim freely in the ocean – watch out for my sting!

____

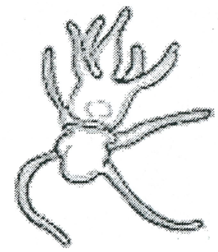
Invert Infants – *Answer Key*

Like butterflies, marine invertebrates undergo life cycle changes in the ocean. They may start out life looking very different from their adult form. Use the pictures and the clues below each to figure out what these rocky seashore invertebrates will look like when they grow up.



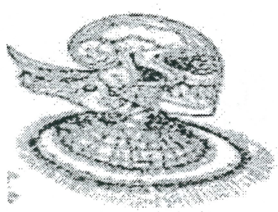
While I float around in the ocean now, when I grow up I will cement my head to a rock and start to use my feet for feeding.

______________Barnacle_________________



I have a lot of appendages now, but when I get older I will only have 5 arms. Unless, I lose one, and in that case I will just grow it back.

________________Sea Star________________

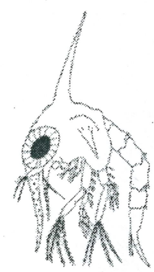


I may look strange now, showing all these soft body parts, but when I grow up all this will fit inside a nice two-part shell.

_________Mussel, Clam or Oyster____________

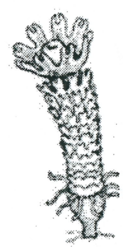
My flat body will plump and become pickle-lie as I grow up. I will also develop a new trick when I get stressed – I will spit out my guts.

____________Sea Cucumber________________



This may be a weird look right now, but come back in a few weeks when I'm covered by an exoskeleton and develop two claws for pinching.

_____________Crab or Lobster______________



In this stage of my life, I may look like I'll live attached to the seafloor, but I will soon swim freely in the ocean – watch out for my sting!

________________Jelly______________________

Squid Dissection

Goals:

- Students are able to gain a greater understanding of invertebrate morphology, anatomy and behavior.

Objectives:

- Students are able to identify at least 4 anatomical features of the squid and describe their function.

CA Standards

Life Sciences:

3.3.a. Students know plants and animals have structures that serve different functions in growth, survival, and reproduction.

Listening and Speaking:

3.1.1. Retell, paraphrase, and explain what a speaker has said.

National Standards:

Science

NS.K-4.1 Science as Inquiry

NS.K-4.3 Life Sciences

Materials:

- Scissors
- Newspapers
- Paper towels
- Fresh squid $3 (one for every 2 students) packs of 10 –12
  Squid can be purchased at a local bait and tackle store
- Squid-Outside Worksheet (provided)
- Squid-Inside Worksheet (provided)
- Squid-Outside Transparency (provided)
- Squid-Inside Transparency (provided)

Setup:

- Make one copy of both the "Squid-Outside Worksheet" and "Squid-Inside Worksheet" per student.
- Cover entire desk/ table with newspaper or butcher paper.
- Set out one set of scissors for each pair of students.
- Make sure squid has had time to thaw (or you can place it in hot water in a bucket to speed the process).

Procedure:

Introduction (20 minutes)

- Have students gather in the front of the room and sit on the carpet, if space allows. If not, wait until the introduction is done before passing out the squid.
- Explain to students that they will be dissecting a squid. Ask students if they remember what "dissection" means. *Answer: dissecting is cutting an animal open and seeing what is on the inside.* Explain that before doing a dissection, it is important to learn more about the animal, so that you know what you're looking at.
- Most animals in Phylum Mollusca have:
    - A shell for protection (some have lost heir shell through evolution or the shell has become internalized-they will see this on the squid)
    - A mantle that grows the shell and protects the insides (internal organs)
    - A muscular foot to hold onto things and move
- Ask the students for some example organisms in Phylum Mollusca
    - Mussels, snails, oysters, clams, navanax, sea hare, octopi, squid
- Ask students to think about how these different animals all are in the same phyla. They have many similar adaptations, but also many differences. Tell them that we are going to be dissecting a squid, which has some different adaptations than other mollusks. It will also be different than the sea star we dissected with Aquatic Adventures.
- Ask students what they think is different. Squid are strange Mollusks with many interesting adaptations and behaviors. Because they need to be light to swim fast, their heavy outer shell moved inward and now is just a small structure (the pen). They still have a mantle to protect their insides. Ask students what squid have instead of a muscular foot. To help them come up with the answer the teacher can ask students what the squid uses to grab onto things? *Answer: Tentacles!*
- Squid and their close relative the octopus are interesting because they include the smartest and the largest invertebrates in the world. Octopi are the most intelligent. Squid are the largest. Giant squid can reach 18 meters! (or 59 feet!) They live in the deep sea. These creatures were first discovered when dead Sperm whales washed on shore. The sperm whales, which also dive very deep, had giant sucker marks all over their bodies. Scientists determined that this must be from fighting with giant squid, but constant research is providing more and more knowledge.
- Squids and octopi eat fish, crabs, and other invertebrates. Sharks, whales, seals, and sea lions, and others eat them.

Main Activity (30 minutes)

- Tell the students that they are going to return to their desks and begin the dissection. They will be working in pairs.
- Emphasize to the students that as a class, we will look at one body part at a time. Tell them not to jump ahead. Stress the importance of listening and following instructions.
- Remind them of the importance of respect. They need to make sure that they respect this organism, since it gave up its life for science.
- Tell them that you will fill out the "Squid-Outside Transparency" and "Squid-Inside Transparency" as you describe each of the external features of the squid. Student pairs will be expected to complete the "Squid-Outside Worksheet" and "Squid-Inside Worksheet" when the class is done with the dissection.
- External features:
    - Appendages

- Ask the students to count how many appendages the squid have. Also have them look to see if there are any similarities or differences between them. *Answer: there should be 10 appendages. 2 long ones with suction cups at the tips and 8 shorter ones with suction cups all the way up.*
- Tell the students that the long appendages are called tentacles and the shorter appendages are called arms (similar to an octopus)
- Label the arms and tentacles on the Squid-Outside Transparency.

- Eye
  - Ask the students to locate the squids' eyes. Giant squid eyes are the largest in the animal kingdom-it is larger than a beach ball!
  - If the students are feeling brave they can actually remove the lens of the squid. They need to gently pinch the eyeball until they feel something hard and circular like a small pellet or bead. Then they can pull that hard part out. If students are squeamish, this step can be bypassed.
  - Label the eye on the Squid-Outside Transparency.
- Beak
  - Squids have beaks similar to birds. To have the students locate the beak they need to hold the squid like a flower. As the arms and tentacles hang down look in center, there should be a small, dark tip. That is the beak. If the students still can't locate it have them gently squeeze between the eyes and it should push out a little bit.
  - The beak is what the squid uses to tear its food. Since the squid is a member of the cephalopod (meaning "head connected to foot") class, there is little room for the esophagus, which is attached to the beak. If the squid doesn't not chew its food into small enough bites the food will get stuck in the esophagus as it passes through the brain-talk about brain freeze!
  - Label the siphon of the Squid-Outside Transparency.
- Siphon
  - Next ask the students to locate the squid's siphon. The siphon looks like a macaroni noodle and is just above the eye extending under the mantle. If they want they can try and gently stick their pinky finger through the siphon
  - The squid uses the siphon to help it move. The squid pulls water in through the siphon and shoots it out moving by jet propulsion. Compare it to a garden hose, if students were to partially cover the end of the hose, the water shoots out farther and faster.
  - Label the siphon on the Squid-Outside Transparency.
- Mantle
  - Have the students locate the mantle, this is the large protective part of the squid that is covered with dots.
  - The mantle is the part that is most commonly used to make calamari. It is cut into strips and fried.
  - Label the mantle on the Squid-Outside Transparency.
- Lateral mantle fins
  - Next have the students locate the fins. These are the structures that extend off of the top part of the mantle.

        - The lateral mantle fins help the squid move and maneuver. As was previously discussed, squid use jet propulsion to propel themselves up and out of the water, and their lateral mantle fins act like wings for the squid to glide or fly across the water. They can fly the length of a football field! Why would a squid want to fly? *To escape a predator that may be chasing it.*
        - Label the mantle fins on the Squid-Outside Transparency.
    - Chromatophores (crow-mat-o-fores)
        - Now have the students locate the things that look like freckles on the outside of the squid. The "freckles" on the mantle of the squid are called chromatophores. These allow squid to change color. Color change can occur in the blink of an eye and is seen when a squid is mad, mating, hunting, eating, and trying to camouflage itself.
        - What is the color of love? *Red.* Many squid turn red when they are looking for a mate. What color would they turn if they were scared? *White.* Many squid turn white when they are afraid. They will also change color to match their background to hide from predators.
        - Label the chromatophores on the Squid-Outside Transparency.
- Tell students that now they will open the squid. To do this they want to place the squid with the siphon side up. They will then use the scissor and cut upward through the mantle. Try to make sure they don't cut downward, or they may cut through some organs.
- Now switch to the "Squid-Inside Transparency". Label the parts as you describe each internal feature of the squid.
- Internal features:
    - Gills
        - The gills can sometimes be difficult to locate. Have the students make the "peace" sign. With these two fingers, they will place them on the outside of the head and while pressing gently pressing inwards and upwards, two almost transparent gills should appear-one on each side.
        - These paired, feathery structures near the intestine are used for breathing. Water passes through the gills and the oxygen is taken and transported all over the body, similar to a fish.
        - Label the gills on the Squid-Inside Transparency.
    - Gonads
        - Does the group think you will dissect a boy or a girl squid. To determine this, the students need to look at the gonads to determine if a squid is a boy or a girl. The male squid have white, creamy sacks, at the top of the mantle (it looks like Elmer's glue). The female squid have a slightly yellowish gel-like sac (it looks like gobs of Vaseline) in the same spot.
        - Label the gonads on the Squid-Inside Transparency.
    - Pen
        - Next have the students locate the pen. It looks like a Capri Sun straw wrapper. Students might think the pen is a bone, but squid are invertebrates. Do invertebrates have bones? *No!*

        - The pen is the remnant of the shell, remind the students that in some mollusks the shell has moved inside. The pen of some squids is taller than they are.
        - Label the pen on the Squid-Inside Transparency.
    - Ink sac
        - Finally have the students find the ink sac. It is blackish-silver and almost looks like a tiny fish.
        - The sac contains black ink that can be shot out to confuse or frighten away a predator. In the deep sea would it do any good for the squid to shoot out black ink? No, because it is always dark. In these places, instead of shooting black ink, the squid will shoot out ink that lights up.
        - Label the ink sac on the Squid-Inside Transparency.
- At this point, students may dissect the remaining parts. They can pull out the beak or find the lens in the eye. After removing the pen, they can break the ink sac and write their names on a piece of paper.

Closing (10 minutes)

- After the dissection have the students work in pairs and fill out the Squid-Inside and Squid-Outside Worksheets. Leave the transparencies visible so that they can use them for reference.

American Indian Invertebrate Trade

Goal:

- Students are able to gain an understanding of the Kumeyaay way of life and the historical role that organisms played in it.

Objectives:

- Students are able to make change in different denominations of currency.

CA Standards:

History/Social Science:

3.2.1. Describe national identities, religious beliefs, customs, and various folklore traditions.

3.2.2. Discuss the ways in which physical geography, including climate, influenced how the local Indian nations adapted to their natural environment (e.g., how they obtained food, clothing, tools).

Mathematics (Number Sense):

3.3.3. Solve problems involving addition, subtraction, multiplication, and division of money amounts in decimal notation and multiply and divide money amounts in decimal notation by using whole-number multipliers and divisors.

3.3.4 Know and understand that fractions and decimals are two different representations of the same concept (e.g., 50 cents is 1/2 of a dollar, 75 cents is 3/4 of a dollar).

National Standards:

Social Science:

NSS-USH.K-4.1. Living and working together in families and communities, now and long ago.

NSS-USH.K-4.2. The history of student's own state and region.

NSS-USH.K-4.4. The history of peoples of many cultures around the world.

Mathematics:

NM-NUM.3-5.1. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

Materials:

- Shell currency pictures (1 per every 2 students)
- Kumeyaay Trade Worksheet (1 for every student)
- Scissors
- Markers, colored pencils or crayons
- Glue stick

Set-up:

- Make enough copies of the shell currency pictures for student pairs

Procedure:

Introduction (20 minutes)

- Ask students if there are any American Indians in San Diego County. Write "Kumeyaay" on the board and tell students that Kumeyaay are the native Californians. They live in San Diego and Imperial counties and stretch as far south as Baja California. They have lived here for more than 10,000 years.
- Ask the students, if they were Kumeyaay, what would be some essential items that they would need in order to survive. Answers should revolve around food, shelter, clothing and tools. Ask the students how they get food and clothing. *Answer: they go to the store and purchase it*.
- Kumeyaay Indians lived in San Diego before the arrival of Westerners. They did not have a dollar bill currency like we do. Ask the students how they think Kumeyaay obtained the items they needed. Have them pretend to be a Kumeyaay for a moment. Tell them that they have decided to buy a new pair of agave sandals. How would they get them? Remember, they can't buy them in a store, so how did they get items that they wanted that they couldn't make or find themselves? They traded.
- American Indians traded for items they themselves could not make, and sometimes tribes traded using seashells, referred to as wampum. Have students name some invertebrates that have shells. Write their answers on the board. Ask students which phylum do all of these animals belong to? Answer: Mollusca.
- Explain to students that today they are going to be native Kumeyaay people and that they are going to have to purchase the necessities they need using wampum.
- Hand out the shell images to the student pairs. As a group they are going to assign values to the different shells, similar to our own currency.
- Ask the students how much a penny is worth. It is 1 cent, meaning that it would take 100 pennies to make a dollar. So a penny is worth $1/100^{th}$ of a dollar. In our activity the olive snail shell (the one with 9 shells) will be worth 1 cent each, so have the students write the value somewhere on the shell. (Hold up an example of the olive shell.)
- Ask the students how much a dime is worth. It is 10 cents, meaning that it would take 10 dimes to make a dollar. So a dime is worth $1/10^{th}$ of a dollar. In our activity the mussel shell (the one with 4 shells) will be worth 10 cents each, so have the students write the value somewhere on the shell. (Hold up an example of the mussel shell.)
- As the students how much a quarter is worth. It is 25 cents, meaning that it would take 4 quarters to make a dollar. So a quarter is worth $1/4^{th}$ of dollar. Ask the students how much three quarters would be? 75 cents. The abalone shells (the one with only 2 shells) will be worth 75 cents each, so have the students write the value somewhere on the shell. (Hold up an example of the abalone shell.)
- If time permits, allow the students to color the different shells to distinguish them from each other. Have the students use the scissor and cut out all the shells along the dotted line.

Main Activity (20 minutes)

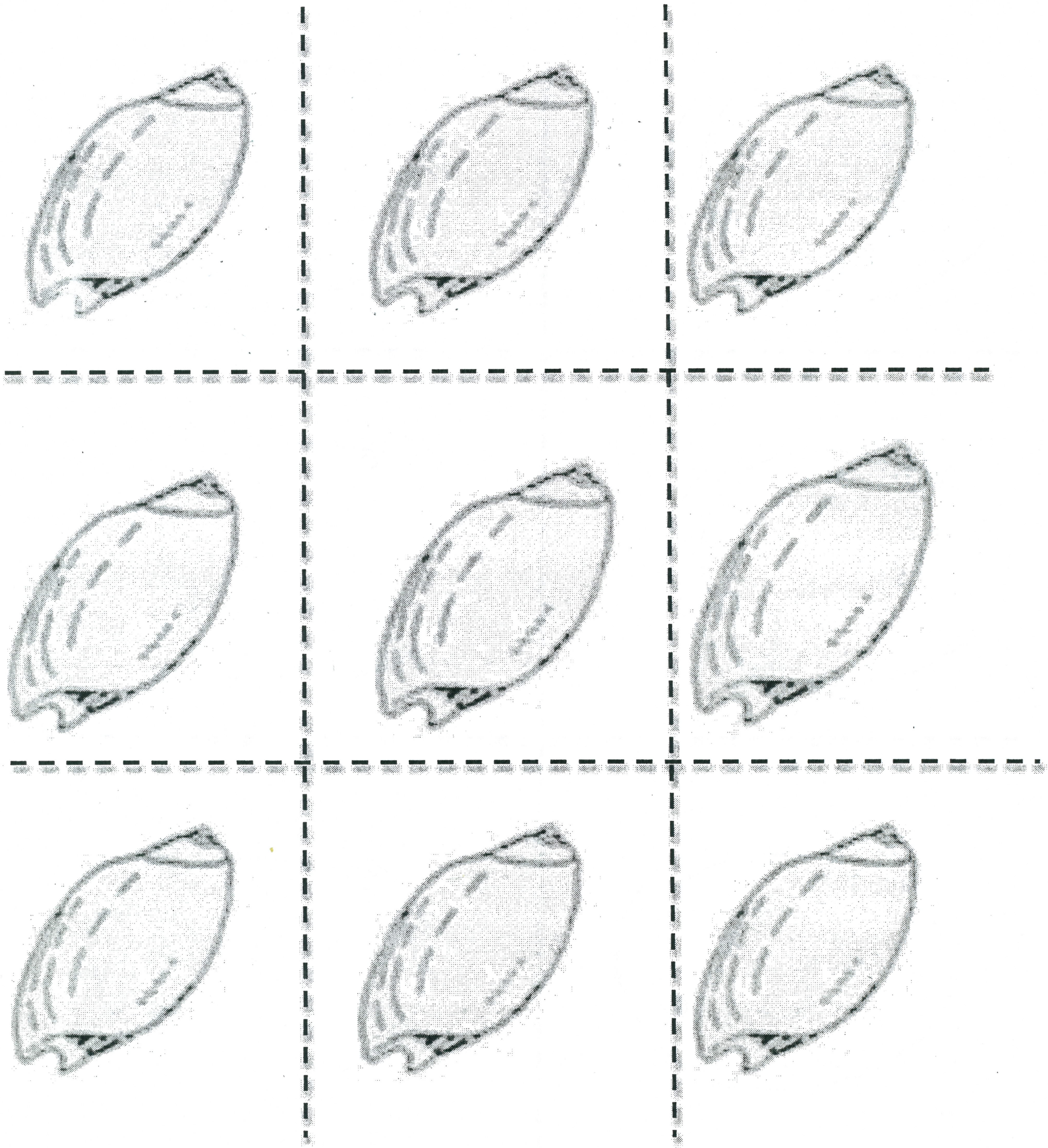
- Tell the students that they will be able to engage in trade the Kumeyaay way. They will each need to trade shells for certain items that they need in their day-to-day existence. For practice, ask the students what they would have to trade to get the agave sandals if the sandals cost four cents. Have them hold up the amounts for you to see. Go around and check that each student is holding four olive snail shells.

- Pass out the Kumeyaay Trade Worksheet to every student (the students will still be sharing the shell cut-outs, but using their own worksheets). Tell the students that they must trade wampum for the items on their list. They will paste the correct number of shells below each question. They must paste the exact amount, since they will not be able to get change back.

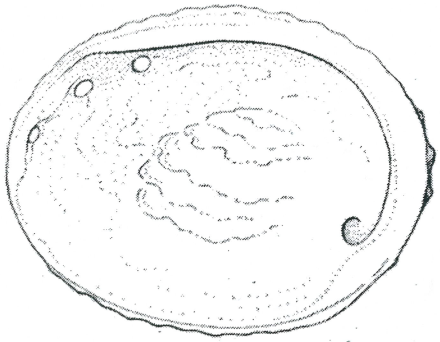
Conclusion (10 minutes)

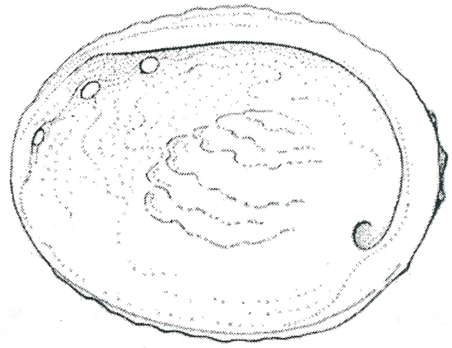
- As a class, go over the answers.
- Ask the students if they think Kumeyaay life would be difficult. What would be some similarities to their lives (they played games, they traveled, they sang songs, they told stories)? What would be some of the differences?
- Remind the students that there are still Kumeyaay Indians that live in the area, but their lifestyles have changed.

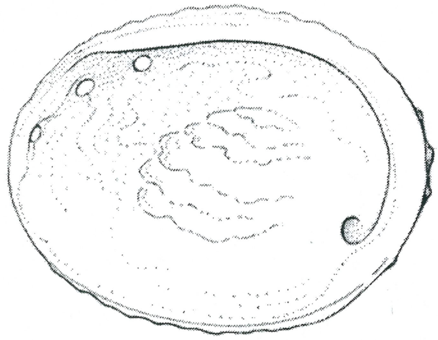
Olive Snail Shells

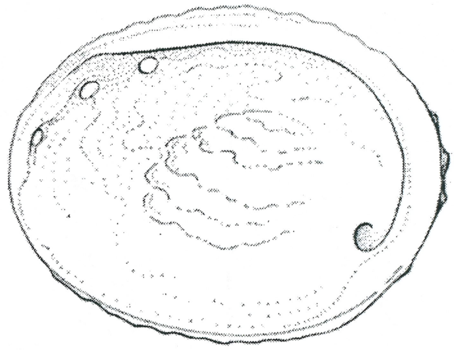


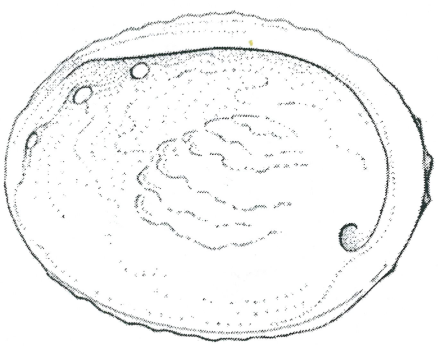
Abalone Shells

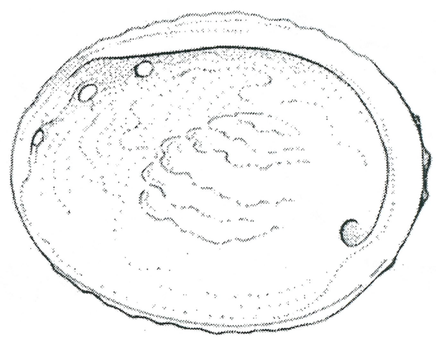




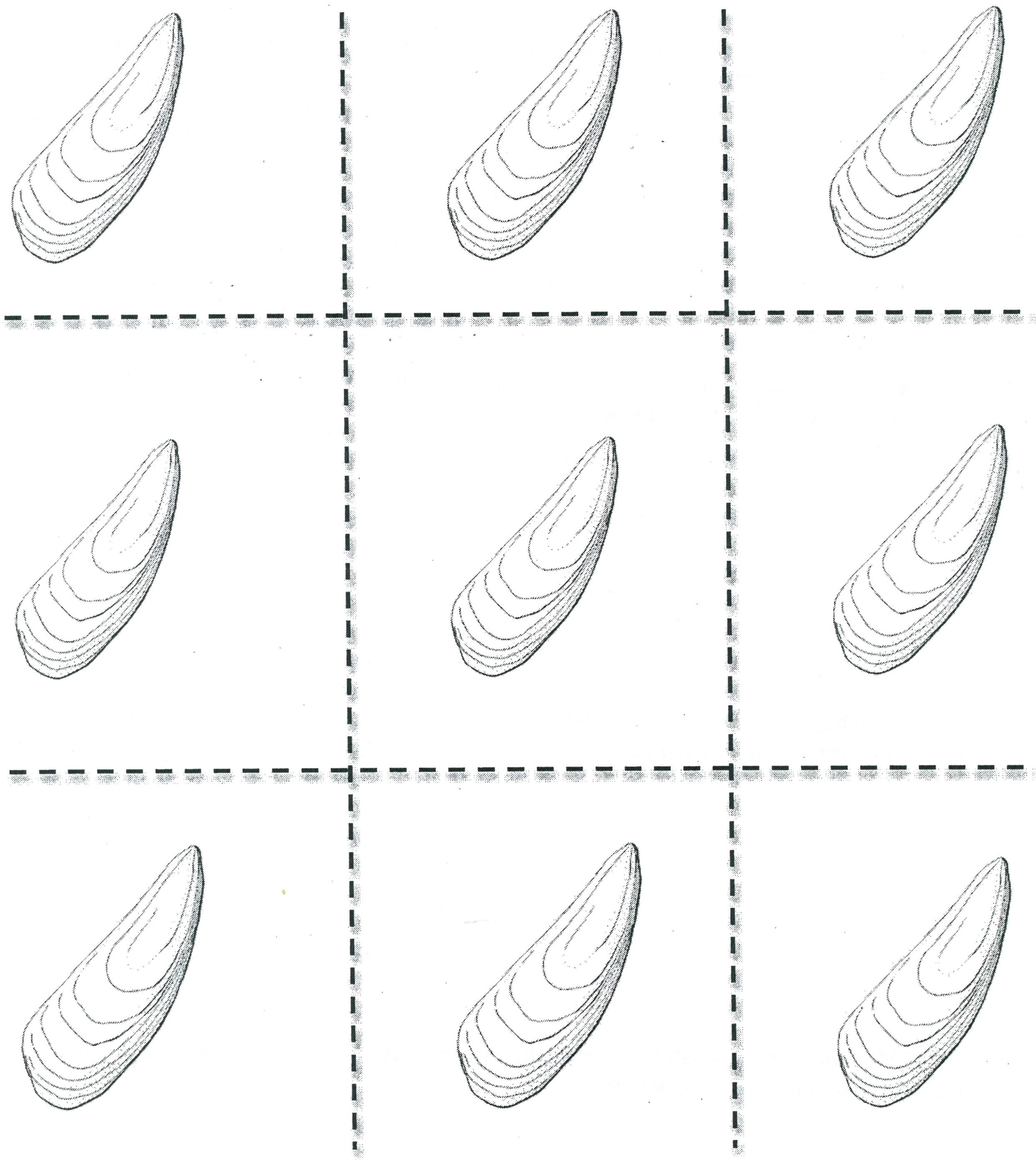








Mussel Shells



Name: ______________________________ Date: ____________________

Kumeyaay Trade Worksheet

1. You need to buy a new belt made of yucca fibers. It costs twelve cents. Paste the correct amount of currency below.

2. You need to buy a new willow bark skirt for your sister. It costs twenty-one cents. Paste the correct amount of currency below.

3. You need to buy some obsidian for making new tools. It costs seventy-six cents. Paste the correct amount of currency below.

4. You need to buy some soapstone for straightening arrows. It costs eighty-five cents. Paste the correct amount of currency below.

Ancient Oceans

Goal:

- Students are able to gain an understanding about changes that have occurred over millions of years in the ocean.

Objectives:

- Students are able to name as least two ocean invertebrates that are no longer present in our oceans.
- Students are able to list at least one cause of a mass extinction.

CA Standards:

Science

3.3.d. Students know that when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

3.3.e. Students know that some kinds of organisms that once lived on Earth have completely disappeared and that some of those resemble others that are alive today.

National Standards:

Science

NS.K-4.3 Life Science
NS.K-4.6 Personal and Social Perspectives

Materials:

- Ocean Images – Ancient and Present (provided)
- Ancient Oceans Handout (provided)

Setup:

- Make a copy of the Ocean Images document for every student.
- Make a copy of the Ancient Oceans handout for every student.

Procedure:

Introduction (15 minutes)

- Ask students to list some of the invertebrates that they have been studying from the rocky seashore. Answers will vary.
- Next ask the students how old they think some of these animals are. Explain that you are not asking how old the individual animal is – since most do not have a very long life span. Tell them you want them to make a hypothesis about how long mussels or sea stars or sea anemones have been present on the planet Earth. Were they here when the first humans came into being? Were they here when the mastodons and mammoths walked the earth? Were they here when the dinosaurs roamed?
- Tell the students that the answer to all these questions is yes. Invertebrates are over 500 million years old! That means they have been present on Earth before humans,

mastodons and dinosaurs. Even before fish, amphibians and reptiles. Invertebrates from many different phyla became widespread during a time known as the Cambrian Explosion around 530 and 520 million years ago (it gets its name because at this time life exploded forth on our planet). For contrast, dinosaurs appeared roughly 215 million years ago and died off 65 million years ago. Homo sapiens probably evolved around 150-200 thousand years ago.

- Next ask the students if they think that the invertebrates that lived in the oceans 500 million years ago would look the same as the invertebrates that live in the ocean today. *Answer: No, things have definitely changed.* Ask the students why they think the invertebrates have changed over time. *Because their environment has changed and they need to adapt to those changes.*
- Ask students what are some events that could have occurred that caused changes in the ocean environment. *Potential answers include: rise of new organisms, extinction of organisms, changes in the pH of the ocean, changes in the temperature of the ocean, changes in the oxygen levels of the ocean, melting glaciers, change in sea level, etc.*
- As changes occur in any habitat, organisms can react in one of three ways: they can move to a new location, they can adapt to the changing conditions, or they can die. Remember that these processes are usually slow, especially adaptation.
- Explain to the students that there is a name given to the process when a change does occur and all members of a certain type of organism die. Ask the students if they know what this is called. *Extinction.*
- Ask the class if they know what extinction is. Extinction is when all the members of a certain group are no longer living – they have died off.
- Next ask the students if they know any species or groups that have gone extinct. *Potential answers include: dinosaurs, saber tooth tigers, mastodons, wooly mammoths, the dodo, passenger pigeon and stellar sea cow.* Over 99% of all species that lived on earth have gone extinct. This may sound like a lot, but the Earth has changed considerably over time and different organisms have gone extinct. There are believed to have been five mass extinctions since life evolved, one which the students will be most familiar is the mass extinction that killed the dinosaurs.
- Explain to students that there is no one single cause for all extinctions. Dinosaurs probably went extinct because of an asteroid strike. Saber tooth tigers, mastodons and mammoths probably went extinct by a combination of changing climate (it got warmer) and hunting by humans. The dodo, passenger pigeon and stellar sea cow went extinct due to hunting by humans.

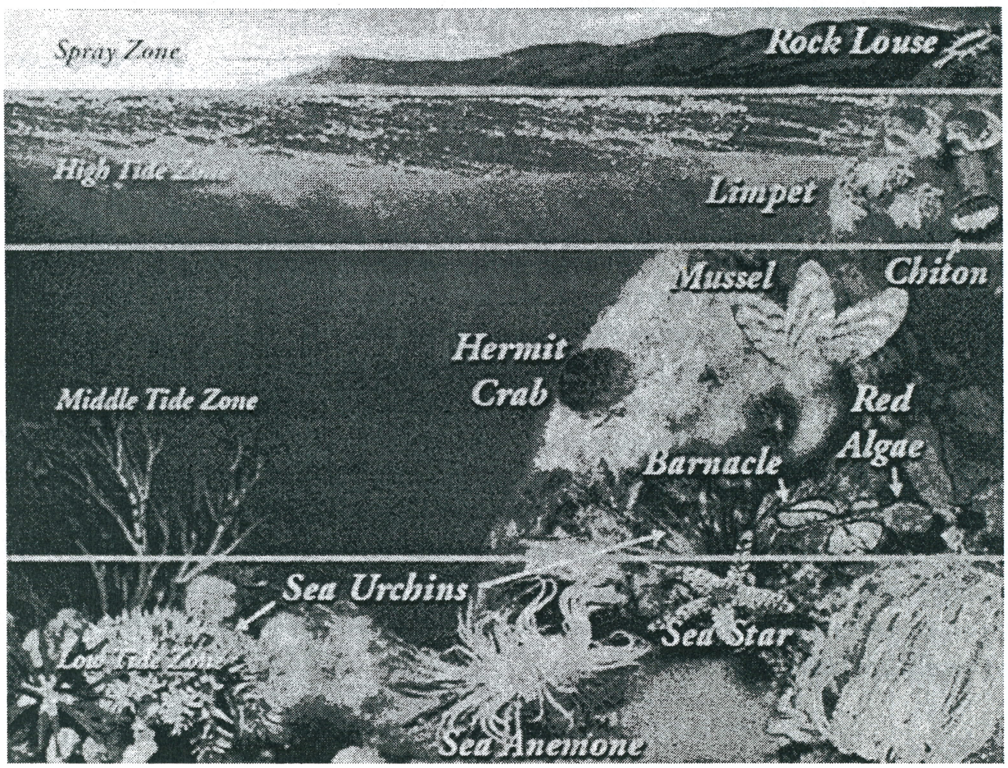
Main Activity (20 minutes)

- Explain to students that today they are going to be looking at a picture of the ocean from millions of years ago and a picture of the ocean today. They are going to have to compare the two, looking for similarities and differences between the organisms that lived in the ancient oceans those that are alive today.
- Pass out the Ancient Oceans handout to the class.
- Given them about 10-15 minutes to answer the questions.

Closing (15 minutes)

- Review responses as a class. With regards to the last question – the cause of the extinction – scientists themselves are not in agreement. Some think it had to do with a rapid cooling of the planet. Others think there was a decrease in the amount of oxygen available.
- Ask the students if they think organisms on Earth will continue to change. *Yes*. Next ask why they think animals will continue to change. *Animals will continue to change because their environments are always changing.*
- Ask students to think of ways the Earth is changing right now that might effect animals. *Potential answers include: climate change, habitat loss, pollution, sea level rise, melting glaciers, etc.*
- Ask students what are the three ways that animals respond to changes in their environment. *The move to a new location, adapt or die.*
- Ask the students if they think that there will be any more extinctions on Earth. *Yes, but this doesn't mean that humans will cause them all.*
- Next ask the students if they know any animals that are at risk of extinction right now. *Answers will vary, but could include lots of amphibians, several species of whales and dolphins, several monkey species, lots of bird, rhinoceros, elephants, etc.*
- Tell the class that there are over 5,400 animal species and over 5, 700 plant species that are at risk of extinction according to the World Conservation Union.
- Ask the students if they think that there is anything that they can do to prevent some of the current species extinctions.

Ocean Images – Ancient and Present



Present Ocean

Ancient Ocean (around 350 million years ago)

Name: ______________________________ Date: ______________________

Ancient Oceans

1. Circle at least three invertebrates in the Ancient Ocean picture that are not in the Present Ocean picture.

2. Redraw one of the Ancient Ocean invertebrates.

3. Describe some of the adaptations that this invertebrate has? Why do you think that they have these adaptations?

4. Are there any similarities between the invertebrates in the Present Ocean and the Ancient Ocean? Explain.

5. What differences do you see between the Present Ocean and the Ancient Ocean?

6. Some of these invertebrates went extinct over 500 million years ago (way before the dinosaur extinction. What do you think caused these invertebrates to go extinct?

Phases of the Moon Calendar

Week One	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:
Week Two	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14
	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:

Phases of the Moon Calendar

Week Three	Day 15	Day 16	Day 17	Day 18	Day 19	Day 20	Day 21
	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:
Week Four	Day 22	Day 23	Day 24	Day 25	Day 26	Day 27	Day 28
	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:	Observations:

Scientific Careers

Goal:
- Students learn about different career paths in the science field.

Objectives:
- Students are able to list at least three different scientific careers.
- Students are able to understand some of the difficulties and some of the rewards that are involved with work in the field of science.

CA Standards:

Reading Comprehension

3.2.3. Demonstrate comprehension by identifying answers in the text.
3.2.5. Distinguish the main idea and supporting details in expository text.
3.2.6. Extract appropriate and significant information from the text, including problems and solutions.
3.3.3. Determine what characters are like by what they say or do and by how the author or illustrator portrays them.

Writing

3.1.1. Create a single paragraph.

National Standards:

NS.K-4.1 Science as Inquiry
NS.K-4.6 Personal and Social Perspectives
NS.K-4.7 History of Nature and Science

Materials:
- Talking with Adventurers (provided)
- Interview Questions list (provided)
- Investigative Interview worksheet

Setup:
- Make a copy of the Investigative Interview worksheet for every student.
- Have the names of the different scientific adventurers on slips of paper for students to select at random.

Procedure:

Introduction (15 minutes)
- Tell students that they will are going to be performers. They will take turns being either interviewer or scientific researcher.
- As the scientific adventurer, students will become that person – acting like them, talking like them and even dressing like them during an interview in class the following day. Students are going to pick the name of a scientific researcher at

random. They will read their biography in Talking with Adventurers focusing mainly on the following four questions:
    - How do you choose a project?
    - What is a normal working day like for you?
    - What was your biggest discovery? What are you most proud of?
    - What is left for you to explore?
- Students many complete additional research online so that they can properly answer questions about this person.
- Each scientific adventurer is then going to be interviewed.
- As the interviewer, students will write a paragraph summary about the adventurer for a local newspaper. A list of questions is provided for them to select a few from – there is not time for all the questions to be asked, so tell the students that they will need to pick 4-5 questions that will allow them to write a really good paragraph about that adventurer.
- Pair students up into buddies – so that they know who they will be interviewing.
- Then have students pick the slips of paper with the adventurer names out of a hat, so they know who they will be portraying.
- Pass out the Interview Questions list for students so students can pick out the questions they would like to ask when it is their turn to be the interviewer.
- Finally, pass out the Investigative Interview handout to the students, explain that this is for their researcher notes. They will write down the main points of the interview for the bullet points. Once they have done that then they can begin writing their paragraph interview write-up for the newspaper.

Main Activity (50 minutes)

- Select an order for the interviews to take place in and write it on the board.
- Have both the adventurer and the interviewer come to the front of the classroom and sit in chairs so that everyone can see.
- Give each pair about 3-5 minutes for their interviews.
- Interviewers should only be focused on the bullet points, the paragraph will be written later in class or taken home for homework.

Conclusion (10 minutes)

- Collect all of the students' completed Investigative Interview worksheets. Try and combine them into one document, similar to a newspaper. Show the students the completed newspaper.
- Ask the students if there were any careers that stood out to them as interesting.
- Ask the students if there were any careers that weren't discussed that they would like to know about.
- Ask the students if any of them would be interested in a career as a scientific adventurer. Listen to some of the student responses.

Interview Questions

1. How do you choose your project?

2. What is a normal working day like for you?

3. What was you biggest discovery? What are you most proud of?

4. What is left for you to explore?

Investigative Interview

Name of Researcher: ___________________________

Occupation: ___________________________

Notes:

- ___________________________
- ___________________________
- ___________________________
- ___________________________
- ___________________________

Interview Write-up:

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Teaching Tides

Goal:

- Students will gain an understanding of the relationship between lunar cycles and tides.

Objectives:

- Students will be able to know which moon phase results in spring tides and which moon phase results in neap tides.
- Students will be able to define spring and neap tides.

CA Standards:

Earth Sciences

3.4.b. Students know the way in which the Moon's appearance changes during the four-week lunar cycle.

Math: Number Sense

3.2.1. Find the sum or difference between of two whole numbers between 0 and 10,000.

National Standards:

Science

NS.K-4.1 Science as Inquiry

NS.K-4.4 Earth and Space Science

Materials:

- Phases of the Moon image (http://www.wisegorilla.com/images/solarsystem/MoonPhases.gif)
- Phases of the Moon Calendar worksheet
- Tide Chart (http://facs.scripps.edu/cgi-bin/plottide.pl)

Setup:

- Have students assemble in an area with space to move around.

Procedure:

Introduction (20 minutes)

- Remind the students when Ocean Discovery Institute was last here they talked about wave action. In class we are now going to do an activity with tides.
- Hold up a book and ask students what will happen if you let go of the book. *Answer: it will fall to the ground.* Ask students if they know what makes the book fall. *Answer: gravity*. Explain that the earth has gravity and it pulls things towards it.
- Tell students that the moon travels around the earth in a circle called an orbit. You can have students demonstrate – one student (the earth) stands still while the moon moves in a counterclockwise circle around it.
- Now add the sun. The sun also plays a minor role in tidal activity (the moon's role is bigger because it is closer). Now have the student that represented earth move around the sun (the

moon still needs to be orbiting around the earth, so you might want to do this in slow motion so as not to tire out the moon).

- Explain that other planets have gravity and they pull things towards them too. The moon has gravity and it pulls on the earth. The sun has gravity and it also pulls on the earth. The pull from the moon and partially the sun is what causes tides. Tides change because the gravitational pull from the sun and the moon causes a bulging (or pulling) of water to one side of the planet. So different places experience high tides and low tides at different times depending on their location.
- Have the students note that there are certain times when the sun, the moon and the earth are all in a perfectly straight line (have the students representing the orbits stop at just such a moment to demonstrate). Tell the students that when they are in a straight alignment we get things called spring tides. Spring tides are when there are really high, high tides and really low, low tides. So there is a large difference between high and low tide.
- Next have the students note that there are times when the sun, the moon and the earth form a right angle. Again, stop the orbiting students at just such a moment. Tell the students when they do not form a nice line we get things called neap tides. Neap tides are where there is a smaller different between high and low tides.

Main Activity (25 - 35 minutes)

- Explain to the students that they will be doing a long-term experiment over the next four weeks. They are going to determine which lunar phases result in a spring tide and which lunar phases result in a neap tide.
- Tell students that each night there should be at least a slight change in the appearance and position of the moon in the sky.
- Show how to document the shape of the moon on the "Phases of the Moon" image at http://www.wisegorilla.com/images/solarsystem/MoonPhases.gif. Discuss all the phases from new moon through waning crescent.
- In addition to charting the moon's progress, the students will also need to look up their local tide chart and write down one set of the highs and lows. For each lunar phase they will need to document the difference between high tide and low tide (using subtraction).
- Tides can be written as either positive or negative numbers depending on how strong they are. To best explain negative numbers to the students, open the San Diego on-line tide chart at http://facs.scripps.edu/cgi-bin/plottide.pl (this site changes daily with the new tides).
- Describe all the features on the tide chart image. The blue coloring indicates that the tide is coming in, while green indicates that the tide is going out. The peaks represent the highest level that the high tide comes in to relative to the average tide line. Have students note the scale on the side and have them figure out how high the tide rose for each series. At these points the tide would exceed the average and is therefore positive. Now have the students look at the troughs on the image. These represent the lowest level that the low tide falls to. Again have the students look at the scale and note that some of the numbers are negative, this means that the tide is below the average (tell them this is also the best time to go tidepooling since there is more exposed habitat). The students do not need to understand the significance of the negative numbers, but should understand that the tide is below the average.
- Next have the students determine the difference between the high and low tide by subtracting low tide from high.

- Tell students that each day they need to record the lunar phase and one of the high and low tides for that day. They can obtain this information by going to the http://www.hribar.com/san-diego-tide-chart.html website and selecting San Diego, CA from the drop-down menu. For simplicity, avoid having them pick the tides with negatives numbers.

Closing (5 minutes)

- At the end of the four weeks have the students discuss their results. Which lunar cycles had the largest difference between high tide and low tide? Which lunar cycles had the smallest?
- Ideally when the moon was full or new, there should have been the greatest difference in tides because when the moon is full or new there is a straight alignment of the sun, moon and earth. In this straight alignment the gravitational forces of each are working together. At other times the tidal difference should have been smaller, since they aren't in alignment.

Inspect an Invert

Goal:

- Students will learn about the scientific process of classification and observation by examining a deep-sea specimen and drawing conclusions.

Objectives:

- Students will be able to list one environmental complication for living in a rocky seashore habitat and a deep-sea habitat.
- Students will be able to list at least two adaptations to living in the deep-sea habitats.

CA Standards:

Science

3.3.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

Writing Applications

3.2.2. Write descriptions that use concrete sensory details to present and support unified impressions of people, places, things, or experiences.

National Standards:

Science

NS.K-4.3 Life Sciences

Materials:

- Inspect an Invert fact sheet (provided)
- Inspect an Invert photo images (provided)
- Pencils

Setup:

- Make copies of Inspect an Invert fact sheet (one per student)
- Make copies of Inspect an Invert photo images (as many as needed)

Procedure:

Introduction (10 minutes)

- So far the class has learned about marine invertebrates at the rocky seashore. However, there are many other habitats in the ocean that can provide habitat for invertebrates. Ask the students to try and name some. *Possible answers could include: coral reefs, mud flats, kelp forests, open ocean, deep sea, etc.*
- Remind students that they have been able to learn a lot about invertebrates by looking at their adaptations. Each habitat can provide unique challenges that an invertebrate has to cope with. Ask the students what are some of the environmental factors that make living in the rocky seashore difficult. *Possible answer could include: waves and tides changing water levels, drying out during low tides, sun exposure, finding food, humans altering their habitat etc.*

- Tell the students that now they are going to examine an invertebrate from a deep sea habitat. Ask the students what are some of the environmental factors that would make living in the deep sea difficult. *Possible answers could include: lack of sunlight, lots of pressure, cold temperatures.*
- Now have the students think about some adaptations that invertebrates living in deep-sea habitats would need to survive. *Possible answers could include: large eyes or no eyes, gel-like bodies with no hard parts, being cold-blooded, etc.*

Main Activity (30 minutes)

- Tell the students that they will now get to play the role of a scientist. Tell them to pretend that they just got back from a research cruise looking at the deep sea animals of the Pacific Ocean. When they were back at the lab, they began examining some of the invertebrates that they had collected and came across a rather large, weird looking creature.
- Using the knowledge that they have gained from Ocean Science Explorers they are going to draw conclusions about this invertebrate and its habitat.
- Pass out one Inspect an Invert fact sheet to each student and go over all the questions before handing out the creature image. See if any of the students have questions.
- Lastly, hand out the image of the deep sea invertebrate – either one per student pair or one per table.

Closing (15 minutes)

- Tell the class that this animal is a giant deep sea isopod. They are closely related to the pillbugs that commonly appear in gardens.
- These invertebrates are carnivores that hunt for food in the deep sea floor. They are essentially scavengers, eating bits of dead food that have floated down from the upper layers of the ocean.
- This invertebrate crawls along the sea floor and can curl up into a ball and use the armored plated along its back for protection when threatened.
- Survey the class and see which phylum they thought that the isopod belonged to. The answer is Arthropoda, it is actually one of the biggest marine arthropods in the ocean.
- Tell the students that these animals can get pretty large, compared with terrestrial invertebrates. Have them examine the image again and note that in the second picture, the isopod barely fits into the human hands. They can reach lengths greater than a foot. Tell the class that there is a lot of gigantism in deep sea creatures, though it is not entirely known why. Some scientists think it has to do with controlling temperature, lack of food or greater pressure.

Name: ______________________________ Date: ________________

Inspect an Invert

Answer the following questions using complete sentences.

Describe the invertebrate's appearance:

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This animal probably eats:

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This animal moves by:

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This animal protects itself by:

____

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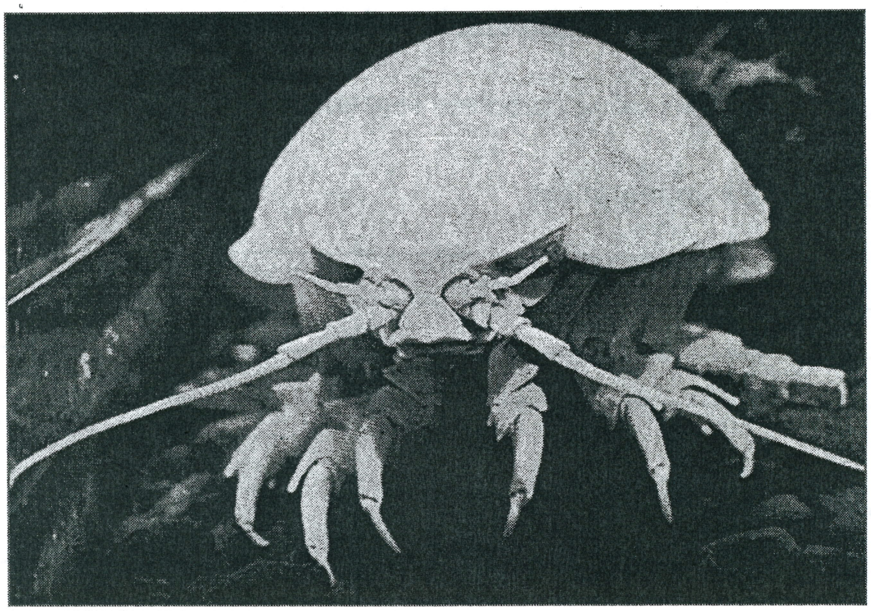
____

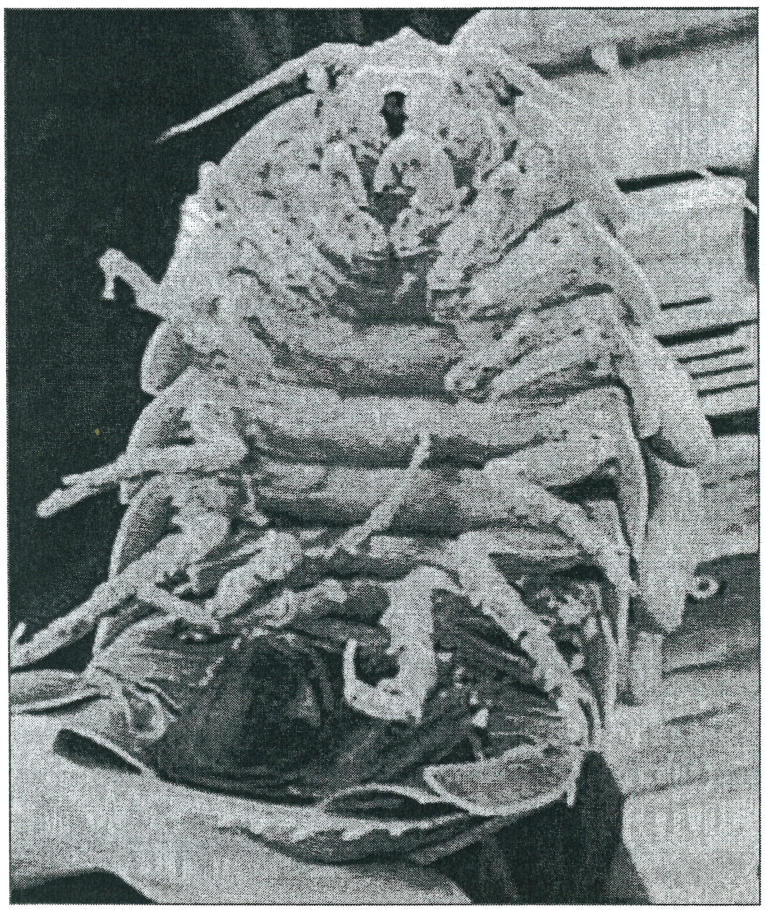
This invertebrate probably belongs to which phylum?

Arthropoda　　Cnidaria　　Echinodermata　　Mollusca

Mystery Invertebrate



(front view)



(bottom view)

Ocean Exploration

Goal:

- Students develop journal skills by writing and researching for a travel log on a deep-sea expedition.

Objectives:

- Students are able to identify at least two complications of living in the deep sea.
- Students are able to describe what traveling in a submersible would be like.

CA Standards:

Writing

3.1.1. Create a single paragraph.

3.1.3. Understand the structure and organization of various reference materials (e.g., dictionary, thesaurus, atlas, encyclopedia).

Writing Applications

3.2.2. Write descriptions that use concrete sensory details to present and support unified impressions of people, places, things, or experiences.

Written and Oral English Language Conventions

3.1.1. Understand and be able to use complete and correct declarative, interrogative, imperative, and exclamatory sentences in writing and speaking.

Science

3.1.b. Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

National Standards:

Science

NS.K-4.5 Science and Technology

NS.K-4.7 History of Nature and Science

Materials:

- Pre-Departure Crew Instruction Manual (provided)
- Research materials on deep sea life
- Writing Paper for journal

Setup:

- Make a copy of Pre-Departure Crew Instruction Manual for each student.

Procedure:

Introduction (10 minutes)

- Remind the class that over the last few months they have become rocky seashore specialists. They have learned a lot about the life in this habitat.

- Tell the class that now they will get the opportunity to understand what it is like to explore a different habitat – those of the hydrothermal vents.
- Explain that for a long time people didn't think there was life at the bottom of the ocean. Ask the class why people – even scientists – would think this. What is it about the deep sea that would make it hard to live there? *Potential answers include: it's cold, it's dark, there's a lot of pressure, there's not a lot to eat down there, etc.*
- Explain to the class that scientists have recently been studying deep-sea habitats, and have discovered hydrothermal vents. Hydrothermal vents are like volcanoes or chimneys on the seafloor; hot fluid comes out of them like smoke – sometimes this water is as hot as 400° C. Remind students that water boils at 100 at 100° C or 212° F, so 400° C is extremely hot! You would think that nothing could live in this super hot water, but it turns out that as scientists have continued to investigate these vents lots of organisms do.
- Ask students to remember what kinds of difficult physical factors organisms living down there have to deal with. *Potential answers include*: *it's cold, it's dark, there's a lot of pressure, there's not a lot to eat down there, etc.* Ask students if they think organisms that live at the bottom of the seafloor near hydrothermal vents need to have special adaptations. *Yes.*
- Hydrothermal vents are fairly new to science, having been discovered in 1977 – proving that we essentially know more about the moon than we do about our own ocean.
- Since their discovery there have been a lot of expeditions to study these communities, scientists are slowly learning a lot about the vents and the organisms that live there.

Main Activity (45 minutes)

- Tell the class that they have been selected to be part of the Undersea Exploration Team and their job is to travel in submersibles to retrieve a black smoker – one of the previously mentioned seafloor chimneys. Part of their responsibility as a crewmember is to keep a log or journal of their activities – in particular what it is like to travel in a submersible and some of the amazing animals that they find.
- Tell them that on almost every expedition that travels into the deep sea, scientists find organisms that have previously never been seen before – they are brand new to science.
- While the class is on their research cruise, they will find an organism that is brand new to science. Their job is to draw and describe this organism in a journal entry. They need to include:
    - A name for the species
    - A physical description as well as a sketch
    - A brief discussion of some of it's adaptations
    - What it eats and how it finds food
    - How it moves
    - Where it was found
- Hand out the Pre – Departure Crew Instruction Manual. This contains a briefing on the exploration that they students will be partaking on. Students may also need some time to research some of the animals that live around hydrothermal vents to understand these animal's unique adaptations.

- Remind students to use their imagination when filling out the journal entry. They should include details about what it is like to be in a submersible in the deep sea. What kinds of things would they feel or see, etc.
- If students are unfamiliar with keeping a journal briefly discuss the things that a journal entry needs: name, date, time, location and it needs to be in complete sentences.

Closing (10 minutes)

- Have students share some of their deep-sea creature creations – in particular discussing some of the adaptations that their organisms have.
- Review some of the adaptations that the deep- sea creatures have to combat the harshness of their environment.
    - Little to no light – some organisms will become completely blind and others will create their own light – like the anglerfish in Finding Nemo.
    - Extreme pressure – most bodies are not very rigid and they lack large air or gas filled organs.
    - Not a lot of food to eat – some of these animals have very slow metabolisms, so they don't need to eat as often. Also some animals have ways of luring prey to them.

CLASSIFIED DOCUMENT:

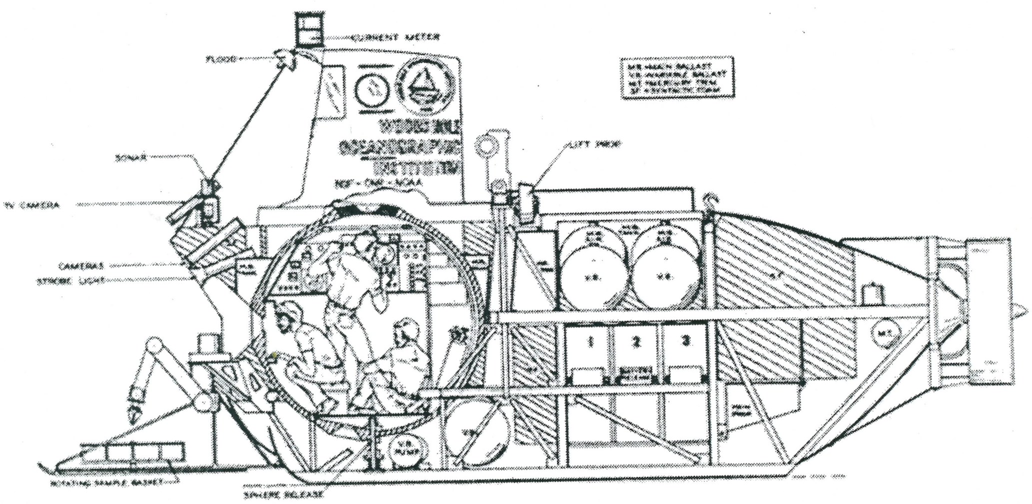
Pre – Departure Crew Instruction Manual

TRAVEL SCHEDULE:

6/16 – Board the Research Vessel *Revelle.* Set sail.
6/19 – Survey in Submersibles and Scientific Tests
6/20 – Survey in Submersibles and Scientific Tests
6/21 – Survey in Submersibles and Scientific Tests
6/22 – First attempt to retrieve black smoker
6/23 – Second attempt to retrieve black smoker
6/24 – Secure black smoker to the deck
6/25 – Secure black smoker to the deck Day 2.
6/26 – Begin return travel

SUBMERSIBLE INFORMATION:

- The submersible only dives once per day, for about 8-9 hours. It take about 1 ½ hours to get down and 1 ½ hours to get up, leaving about 5-6 hours on the bottom.
- There is room for only 3 people inside, 1 pilot and 2 observers. There are no bedrooms, no kitchen, and no toilet – see drawing.



POTENTIAL ANIMALS:

- Giant Tubeworms (up to 7 ft. tall)
- Pompeii Worms (live with bacteria on their back)
- Blind Shrimp

Name: ______________________________

Location: ____

Date ________________________________ Time: _______________

Conditions: ____

Observations and Findings:

Once Upon a Storm Drain

Goal:
- Students develop their narrative writing skills by creating a story about travel through the storm drain to the ocean.

Objectives:
- Students are able to identify where storm drains flow to.
- Students are able to identify three different components of plot.

CA Standards:

Writing Applications

3.2.1. a. Write narratives: Provide a context within which an action takes place.
3.2.1. b. Include well-chosen details to develop the plot.
3.2.1. c. Provides insight into why the selected incident is memorable.

Literary Response and Analysis

3.3.3 Determine what characters are like by what they say or do and by how the author or illustrator portrays them.
3.3.4 Determine the underlying theme or author's message in fiction and non-fiction text.
3.3.6 Identify the speaker or narrator in a selection.

Life Sciences

3.3.a Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.
3.3.c Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

Materials:
- All the Way to the Ocean by Joel Harper (provided)
- All the Way to the Ocean – text (provided)
- Once Upon a Storm Drain – Story Outline (provided),
- Once Upon a Storm Drain – Example Story (provided)
- Storm drain poster
- Paper and pens

Setup
- Make one copy of "Once Upon a Storm Drain – Story Outline" per student.
- Make copies of the "All the Way to the Ocean – text" as needed.
- Before the book is read with the students, be sure to preview the text and pull out any vocabulary or concepts that the students may have difficulty with. Write

these vocabulary terms and concepts down so that they can be discussed as they are read within the text.
    - Chart the vocabulary and concepts and have students assist in completion.
- Adaptation: This lesson can be done in guided reading groups as well as a read aloud. Copies of the text can be used (text is attached) for students to follow as it is read aloud to the class. In small reading groups, there is also the option of rotating the groups just in discussion, and allowing the students to read the text on their own.

Procedure:

Introduction (10 minutes)

- Explain to the students that a watershed is the flow of water, from snow or rain in the mountains, traveling downward through rivers and streams, collecting in rivers and streams and eventually reaching the ocean.
- Storm drains also occur within a watershed. Tell students that they might have seen signs painted onto the sidewalk or curbs that say "No dumping – I live downstream" with a picture of a duck or a dolphin- that's a storm drain. These pipes meet underground and flow out straight into bays or oceans.
- Anything dumped or dropped on the street flows into storm drains when it rains. Ask the students, what else (besides water) flows through storm drains? Answer: dog poop, soap, oil, trash thrown on the street such as gum wrappers and cigarette butts.
- Let the students know that this pollution and trash flows through the storm drain and then spills directly into the oceans. There are no filters on storm drains, so whatever gets carried or dumped into them will eventually end up in the ocean.
- Ask the students how this trash might affect life in the ocean. Ask students for some examples. *Pollution can make animals sick, animals can get entangled and caught in trash, animals cans eat trash and get sick or suffocate, etc.*
- Ask students if they have heard of beaches being closed after it rains. Explain that the reason for this is that right after it rains, all the trash and pollutants go into the storm drains and then the ocean – which can make humans sick.

Main Activity (40 minutes)

- Tell students that you are going to read a book, All the Way to the Ocean, about two boys and what they learn about storm drains. As you read, stop and ask students questions about the main characters and how they change through becoming aware of the consequences of their actions.
- After reading the book, ask students about the setting, plot, and what the author's main point was. Review any of the concepts as necessary.
- Explain that they are going to write a story from the point of view of a water droplet, beginning as rain at the start of the watershed and traveling all the way

to the ocean. They will imagine traveling through streets, rivers, storm drains, etc. and write about the different things they encounter.

- Go over the "Once Upon a Storm Drain – Example Story."
- Be sure that the student knows what their story setting is. (Where it takes place) Brainstorm ideas of what a trip through the watershed and storm drains would be like. Write their ideas on the board. What sort of things would flow into storm drains and join the waters.
  - What will it feel like on the street?
  - What will it look, feel, and smell like inside a storm drain or a pipe?
  - What will it feel like to exit the storm drain and enter the bay or ocean?
  - What other things flow through the storm drain? How does pollution and trash harm wildlife?
- Encourage students to use all of their senses to describe their journey.
- Hand out Once Upon a Storm Drain Story Outline worksheets.

Closing (10 minutes)

- Have several of the students share their story with the class or have students' pair shares.
- Students can create illustrations to go along with their story.
- Hang stories around the classroom.

Name: ______________________________ Date: ________________

Once Upon a Storm Drain – Story Outline

Characters:

- Main Character: ______________________ (tells the story)
  NAME
  - Characteristics of the Main Character:
    ____
    ____
    ____

- Other Character: ______________________
  NAME
  - Characteristics of the Character:
    ____
    ____
    ____

- Other Character: ______________________
  NAME
  - Characteristics of the Character:
    ____
    ____
    ____

Setting:

- What season is it?

___

- Is it hot? Cold? What kind of day does it feel like?

___

- What does the inside of a storm drain look like?

___

- What are some other things the main character can see?

___
___
___
___

Plot

- Beginning:
    - *Be sure that you include descriptions of the setting.*
    - *Introduce the characters.*
    - *Introduce the plot (the water moving from rain onto the street)*

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___

- Middle:
    - *Tell what happens to the main character as it travels down the storm drain.*

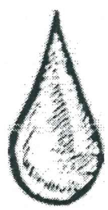
- End:
    - *Tell what happens when the water meets the ocean.*

Name: ____________________________________ Date: __________________

Once Upon a Storm Drain – Story Outline

Characters:

- Main Character: *Willy the Water Droplet* (tells the story)
  NAME

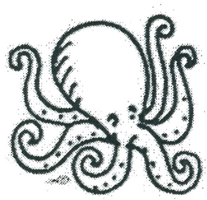


  - Characteristics of the Main Character:
    Blue, clear, cold, little bubbles on the top. Very curious, feeling happy and excited. Just arrived to the streets from the sky

- Other Character: ***Cameron the soda can***
  NAME

  - Characteristics of the Character:
    Shiny, red, little dents, round bottom, one side open. Comes Comes from the streets, finds himself in the storm drain with a new friend.

- Other Character: ***Oscar the octopus***
  NAME



  - Characteristics of the Character:
    Eight tentacles, pinkish in color. Likes to eat things with with shells.

Setting:

- What season is it?

It is springtime.

- Is it hot? Cold? What kind of day does it feel like?

It is a little cold. It feels like a curious kind of day.

- What does the inside of a storm drain look like?

It kind of feels cool and hollow. There isn't much light.

- What are some other things the main character can see?

I can see the outline of the storm drain, it is cool and dark. Only a small amount of light comes through. Water splashes up against the walls. The water has a different smell. There are strange things floating in the water I've never seen before.

Plot

- Beginning:
  - *Be sure that you include descriptions of the setting.*
  - *Introduce the characters.*
  - *Introduce the plot (the water moving from rain onto the street)*

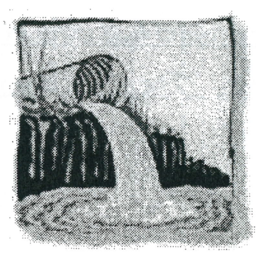
Willy the water had just landed on the street. He had spent so much time in the sky he felt free flying in the air. Suddenly he felt a distinct splatter underneath him. It felt like his whole body had taken on an entirely new form. All of these other water droplets around him were moving somewhere so quickly, and he wondered to himself, "Where is everyone going?". Before he knew it, he was being drawn to a large hole, the place every other water droplet had gone in such a hurry. He asked another water droplet what 'the hole' was. "The storm draaaaiiiinnn," he answered.

- Middle:
  - *Tell what happens to the main character as it travels down the storm drain.*

Willy the Water Droplet, now felt himself in a dark place, with strange noises that seemed to come from everywhere. Suddenly, this strange creature pops up next to him in the water, "Hello!, he says, "I'm Cameron, the can." Cameron the can was shiny, and red, with white swirls all around him. "Welcome to the storm drain!", he said. "Did you come from the sky too?", Willy the Water Droplet asked Cameron the Can. Cameron the Cameron the Can explained that he was once full of a dark bubbly water called soda, but but one day when he was emptied, he woke up from a nap to find himself on the street. He explained that there had been a lot of cars all around him, and then one day a lot of water began falling from the sky, the rainwater and the other pieces of trash in the street had pushed him down the street, and now here he was flowing down the storm drain, with his new buddy, Willy the Water Droplet.

- End:
  - *Tell what happens when the water meets the ocean.*

Willy the Water droplet and Cameron the Can began to see something that looked like light at the end of the tunnel. The water began to move faster and faster. They began to move faster and faster down the pipe, then they were out of the pipe and in a huge body of water. They looked up and there was a big blue sky above them with lots of birds flying over. "Ouch", said Cameron the Can. Willy the Water Droplet, looked over and said, "there's an Octopus trying to eat you. At that moment, Oscar the Octopus looked up and said, "Who me? I'm sorry I thought you were something yummy to eat, but you have a funny taste to you." That's when Cameron the Can explained that he was not from the ocean, and began to explain their journey through from the storm drain.



Ocean Exploration

Goal:
- Students are able to gain familiarity with scientific sampling at the rocky seashore.

Objectives:
- Students are able to cite the difference between diversity and abundance.
- Students are able to state which zone of the rocky seashore has the greatest diversity and/or the greatest abundance.

CA Standards:
Life Sciences:
- 3.3.a Students know plants and animals have structures that serve different functions in growth, survival and reproduction.
- 3.3.b Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

Investigation and Experimentation
- 3.5.a Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because the differences in the things being investigated, methods being used, or uncertainty in the observation.
- 3.5.c Use numerical data in describing and comparing objects, events, and measurements.
- 3.5.d Predict the outcome of a simple investigation and compare the result with the prediction.
- 3.5.e Collect data in an investigation and analyze those data to develop a logical conclusion.

National Standards:
Science
- NS.K-4.1 Science as Inquiry
- NS.K-4.3 Life Science

Materials:
- Quadrat Images (provided)
- Rocky Seashore Samples Worksheet (provided)

Setup:
- Make copies of the Rocky Seashore Samples Worksheet (one per student pair).

Procedure:
Introduction (15 minutes)

- Remind the students that when they were recently at the rocky seashore with Ocean Discovery Institute that they were able to observe nature. Now, tell the students that they will have the opportunity to conduct a scientific experiment involving the rocky seashore.
- Tell the class that when scientists study the ecosystems, they are interested in a couple different things – they want to know how many different types of animals they find and how many of each animal there are. Scientists use the word 'diversity' when describing how many different types of animals there are.
- Ask students if a scientist visited a rocky seashore and was able to find sea hares and urchins would that be a high or low diversity of animals? *Low, because they only found two different types.* If the scientists visited a different rocky seashore and found limpets, sea cucumbers, sea hares, wavy top snails, hermit crabs, sea stars, urchins, octopi and anemones would that be a high or low diversity location. *High*.
- Explain to students that scientists use the word 'abundance' when describing the total number of animals. For example if scientists wanted to know how many urchins there were at a particular rocky seashore that would be the 'abundance' of urchins.
- Ask the class how they think scientists find out about the amount of each type of animal in the rocky seashore. If scientists wanted to know the abundance or how many limpets were at a particular rocky seashore, do they think that scientists would go out and count every single limpet in the whole area? No, there are too many limpets and it would take a very long time!
- Instead scientists use a quadrat to take samples. A quadrat is a tool that measures out a certain area of study. Scientists are only concerned with organisms that fall within the boundary of the quadrat. Anything outside the edges of the quadrat is not counted.
- Scientists can get the abundance of different organisms by counting and recording the number of different organisms within the quadrat.
- Scientists can take the quadrat and place it in different areas in each zone of the rocky seashore. Tel the class that by studying these quadrats in various areas, it can provide a picture for how the whole ecosystem is, without having to count every organism.
- Explain to the students that scientists use this quadrat to measure abundance and diversity in an area and then use the information to determine how many organisms there are in the whole zone.
- Tell the class that they are going to take a quadrat sample of two of the zones in the rocky seashore (the high tide zone v. the low tide zone). But before they do, the class needs to come up with a hypothesis of which zone of the rocky seashore will have the greatest diversity and which zone will have the greatest abundance.
- Briefly review the different zones of the ocean with the class:

  "Splash Zone" with your hands in the air.

  "High Tide Zone" with a high-pitched voice and hands at your shoulders.

"Middle Tide Zone" crouched down waving your arms.
"Low Tide Zone" all the way on the ground with a low voice.

- Write the following two hypotheses on the board. Have the students fill in which they zone (low or high) they think will have the greatest diversity. Likewise for abundance. Students may have the same zone for both.
    - ____________ zone will have the greatest diversity
    - ____________ zone will have the greatest abundance.

Main Activity (20 minutes)

- Have the students form pairs
- Pass out a Quadrat Image to each pair, noting which zone it came from.
- Next, pass out two copies of the Rocky Seashore Samples Worksheet to each student pair (they can be printed on the reverse side).
- Have the students write which zone they are studying in the blank provided.
- Tell the students, that they are now going to be the scientists and record the data that they have found in each of their quadrats. They need to carefully examine their image, count all the invertebrates that are within that image and record the numbers on their Quadrat Worksheet. If there aren't any of a particular invertebrate the students can record a zero. If there are lots of a particular invertebrate (barnacles for example) have the students estimate the number.
- Give the class about five-ten minutes to sample their photo quadrats.
- Next have them switch their image with someone from another zone (if they had high tide zone, they need to switch with someone who has a low tide picture and vice versa).
- Have them use the second page of the Rocky Seashore Samples worksheet to record their finding. Again, give them five to ten minutes to complete their survey.
- Have the students total up their counts at the bottom of each page.

Conclusion (15 minutes)

- Remind students that an important part of the scientific process is to report their findings.
- Draw two columns on the board. One column should be labeled Low Tide Zone, the other column should be labeled High Tide Zone. Have each student share the number of total organisms they counted for both the low tide zone and the high tide zone (abundance). Write the numbers for each team on the board in the correct column, then show the students how to take the average.
- See which tidal zone had the greater abundance. Ask the students if the data collected supported their hypothesis about abundance.
- Next erase the numbers and ask the students to share the different number of species that they counted for both the low tide zone and the high tide zone (diversity). Write the numbers for each team on the board in the correct column, then have the students take the average.

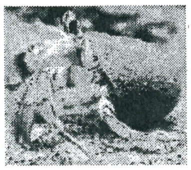
- See which tidal zone had the greatest diversity. Ask the students if the data collected supported their hypothesis about diversity.

Names: ______________________________ Date: ____________

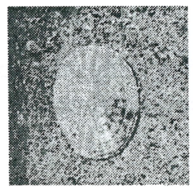
____

Rocky Seashore Samples

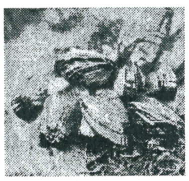
Rocky Seashore Zone: ______________________________



____
Hermit Crabs
(Artropoda)



____
Limpets
(Mollusca)

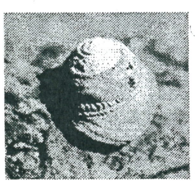


____
Mussels
(Mollusca)

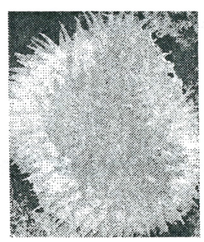
____
Chitons
(Mollusca)

____
Goose Neck
Barnacles
(Arthropoda)

____
Acorn Barnacles
(Arthropoda)



____
Snails
(Mollusca)



____
Anemones
(Cnidaria)

Total Number of Species Found (Abundance) : ______________

Number of Different Species Found (Diversity) : ______________

Lobster Wars

Goal:

- Students are able to gain familiarity with the difference perspectives of fishing and the effects that overfishing has on the ocean.

Objectives:

- Students are able to calculate the profit made during various rounds of fishing.

CA Standards:

Science

3.3.c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

Social Studies

3.5.1. Describe the ways in which local producers have used and are using natural resources, human resources and capital resource to produce goods and services in the past and in the present.

3.5.3. Understand that individual economic choices involve trade-offs and the evaluation of benefits and costs.

Math

Number Sense

3.2.1. Students find the sum or difference of two whole numbers between 0 and 10,000.

3.2.4. Solve simple problems involving multiplication of multi-digit numbers by one-digit numbers (3,671 x 3 = __).

3.2.8. Solve problems that require two or more of the skills mentioned above.

National Standards:

Science

NS.K-4.6 Personal and Social Perspectives

Materials:

- Lobster Wars Worksheet (provided)
- Lobster Wars Teacher's Copy (provided)
- Pencils

Setup:

- Make copies of Lobster Wars Worksheet – one per student

Procedure:

Introduction (10 minutes)

- Ask students to think of some marine invertebrates that they could eat. Answers: crab, squid (calamari), oysters, mussels, lobsters, snails, octopi, urchin, sea cucumber, abalone, shrimp, scallops, clams, and so on.
- Ask the students how the think these animals get from the ocean to the supermarket or restaurant. Explain that there is a long chain of suppliers from the fishermen all the way to the store (i.e. monitoring, processing, testing, packaging, transportation, etc.) For example, talk about the journey that a shrimp has from the ocean to the market: Fishermen check the weather, fuel up, mend any broken nets, purchase bait and head out fishing. The fishermen fish for hours and need to keep what they caught on ice. Periodically they may be boarded by the Coast Guard to ensure that they aren't fishing illegally. Once they get head back to the port, they sell their shrimp to a processor and get paid by how much they caught. The processor then drives the shrimp to a factory where they are cleaned and sorted and packaged. Then the processor drives them to a store to be sold in the market.
- Everyday fishermen have to make decisions on how much to fish. Ask the students what they think are some things that might influence a fisherman's decision to fish? Some answers could be: the price of the catch, the cost of fuel, how far they have to go, weather concerns, the season of the catch, various permits and restrictions.

Main Activity (40 minutes)

- Hand out the Lobster Wars Worksheet to each student and tell the class that they are going to become lobster fishermen today. Each cluster of tables will represent a team of fishermen – there should be 4 teams.
- Explain to the students that lobster season runs from October to March, so lobster fishermen are only allowed to catch lobster between these months. Catching lobster any other time is illegal.
- Tell students that the purpose of the activity is to make money lobster fishing. For simplicity, we are going to fix the price per lobster at $5. Under realistic conditions, the more lobster caught, the lower the price would be. Ask them why they think a painting by Monet (or any other famous painter) is so expensive? Answer: because they are so rare. So if fishermen catch lots and lots of lobsters they are not rare and therefore are not worth as much money.
- Tell the students that they are all fishing from the same lobster population. Ask the students what they think might happen if too many lobsters are caught? If too many lobsters are caught, the population could crash. A population crash is a dramatic decline in the population, resulting in less and less babies getting made each year and therefore becoming closer and closer to extinction. In some populations, the animals can recover after a crash, but most don't. Any industry that relied on that population would go out of business. For example, when the cod stocks crashed off New England, the fishermen all went out business.
- At the start of every round the team needs to decide how intensely they are going to fish. No team can set out more than 10 lobster traps – each trap will yield no more than 16 lobsters. Each team must pick a number from 0-10. Remind each team that they also need to consider the costs of fishing. For every trap that they put out, it will cost them $50. This cost represents the cost of labor, fuel, traps, etc.
- Inform the teams that we will fish for five rounds. They will want to make decisions so that they will make the most money. In addition, during each round some unpredictable "event" might happen. These are things that can't be controlled by the fishermen like good or bad weather, the price of fuel, changing ocean temperatures, etc.

- Give each team three minutes to discuss and decide on how many lobster pots they want to set this round.
- Have students calculate the cost of setting that number of traps. You may need to do an example on the board.
- At the start of each round the team will want to decide how many traps that they are going to set. Based upon whether the fishing was good or poor that round, they will have caught a certain number of lobsters per pot. Remind students that the number of lobsters caught will be a reflection of how intense the fishing pressure was.
- As the teacher, your responsibility is to go around and ask each team how-many pots they are going to set out at the beginning of each round. Try to keep it a secret as much as possible, since each teams decisions could affect other teams. You will record each team's pot total for the round on the Lobster Wars-Teacher Copy (provided). The number of lobster's per pot is determined by how much the class as a whole decided to fish. Use the scale at the bottom to determine the catch and if there was an "event" that affected catches, let the class know.
- The students will be responsible for recording the results on their Lobster Wars Worksheet. They can work as a group, but must tally totals on their own sheets. After they make the decision about the number of costs, they will be able to calculate the total cost that round (Number of Pots x $50). After you have calculated the number of pots set, announced any "events", and told the number of lobster per pot, the students can then calculate their total revenue (Number of Pots x Number of Lobsters in Each Pot x $5). Now that they have total revenue and total cost, they can calculate whether they made money that round or not, by subtracting Total Costs from Total Revenue. Again, an example may need to be here to illustrate to the students what is expected.
- At the end of the five rounds, the students need to calculate their total profit by adding up the profit from each round and writing it at the bottom under the Total Gains or Losses from Fishing. Remind students that if they lost money in a round, they will subtract not add.

Closing (10 minutes)

- Have students share their total gains (or losses) and the strategies that they used to achieve these.
- Ask them what they think would happen in a typical fishery with no restriction. Answer: the species are usually fished until there numbers are so low that they may not recover. Ask students why this could be a problem. Ask students how this might affect other species. Ask the students to think about different food web impacts.
- Ask the students to think of ways that you could help control a fishery so that they don't overfish the stocks.
- Tell the students that some techniques used to control overfishing are no take zones, limitations on fishing (these include limitations on the sex and size of a species), gear restrictions, closed seasons, etc. If the students are interested have them try and research some other alternatives.

Lobster Wars (Teacher's Copy)

Round 1

Ask how many pots each team wants to set this round. Write them down below.
Don't announce to the class every team's choice, since it might influence others.

Team 1_____
Team 2_____
Team 3_____
Team 4_____ Total Number of Pots:_____

Event: " Good weather resulted in high catches this round."
After adding the total # of pots, use this scale to determine how many lobsters/pot:

35-40 Total Pots: 13 lobster/pot
30-34 Total Pots: 13 lobster/pot
25-29 Total Pots: 14 lobster/pot
20-24 Total Pots: 14 lobster/pot
15-19 Total Pots: 15 lobster/pot
10-14 Total Pots: 15 lobster/pot
5 – 9 Total Pots: 16 lobster/pot
0 – 4 Total Pots: 16 lobster/pot

Round 2

Ask how many pots each team wants to set this round. Write them down below. .

Team 1_____
Team 2_____
Team 3_____
Team 4_____ Total Number of Pots:_____

Event: "There was a reduction in the lobster population from the previous round, so there were not as many lobsters available."
After adding the total # of pots, use this scale to determine how many lobsters/pot:

35-40 Total Pots: 9 lobster/pot
30-34 Total Pots: 9 lobster/pot
25-29 Total Pots: 10 lobster/pot
20-24 Total Pots: 10 lobster/pot
15-19 Total Pots: 11 lobster/pot
10-14 Total Pots: 11 lobster/pot
5 – 9 Total Pots: 12 lobster/pot
0 – 4 Total Pots: 12 lobster/pot

Round 3

Ask how many pots each team wants to set this round. Write them down below.

Team 1_____
Team 2_____
Team 3_____
Team 4_____ Total Number of Pots:_____

Event: "Better lobster pots were designed, allowing for higher catches. This coupled with decent weather this round helped increase catches.
After adding the total # of pots, use this scale to determine how many lobsters/pot:

35-40 Total Pots: 12 lobster/pot
30-34 Total Pots: 12 lobster/pot
15-19 Total Pots: 14 lobster/pot
10-14 Total Pots: 14 lobster/pot

25-29 Total Pots: 13 lobster/pot	5 – 9 Total Pots: 15 lobster/pot
20-24 Total Pots: 13 lobster/pot	0 – 4 Total Pots: 15 lobster/pot

Round 4

Ask how many pots each team wants to set this round. Write them down below.

Team 1_____
Team 2_____
Team 3_____
Team 4_____ Total Number of Pots:_____

Event: "Due to the unseasonable cold weather from a La Nina, the lobsters moved further off shore, making it harder to catch."

After adding the total # of pots, use this scale to determine how many lobsters/pot:

35-40 Total Pots: 8 lobster/pot	15-19 Total Pots: 10 lobster/pot
30-34 Total Pots: 8 lobster/pot	10-14 Total Pots: 10 lobster/pot
25-29 Total Pots: 9 lobster/pot	5 – 9 Total Pots: 11 lobster/pot
20-24 Total Pots: 9 lobster/pot	0 – 4 Total Pots: 11 lobster/pot

Round 5

Ask how many pots each team wants to set this round. Write them down below.

Team 1_____
Team 2_____
Team 3_____
Team 4_____ Total Number of Pots:_____

Event: "Due to the overfishing, there haven't been as many baby lobsters born, so catches were down significantly."

After adding the total # of pots, use this scale to determine how many lobsters/pot:

35-40 Total Pots: 5 lobster/pot	15-19 Total Pots: 7 lobster/pot
30-34 Total Pots: 5 lobster/pot	10-14 Total Pots: 7 lobster/pot
25-29 Total Pots: 6 lobster/pot	5 – 9 Total Pots: 8 lobster/pot
20-24 Total Pots: 6 lobster/pot	0 – 4 Total Pots: 8 lobster/pot

Lobster Wars Worksheet

Round 1

Revenue:

____________ x ____________ x \$5 = _______________

(Number of Pots) (Lobsters per Pot) (Total Revenue)

Costs:

____________ x \$50 = _______________

(Number of Pots) (Total Cost)

Profit:

____________ - ____________ = _______________

(Total Revenue) (Total Cost) (Profit: +/-)

Round 2

Revenue:

____________ x ____________ x \$5 = _______________

(Number of Pots) (Lobsters per Pot) (Total Revenue)

Costs:

____________ x \$50 = _______________

(Number of Pots) (Total Cost)

Profit:

____________ - ____________ = _______________

(Total Revenue) (Total Cost) (Profit: +/-)

Round 3

Revenue:

____________ x ____________ x \$5 = _______________

(Number of Pots) (Lobsters per Pot) (Total Revenue)

Costs:

____________ x \$50 = _______________

(Number of Pots) (Total Cost)

Profit:

____________ - ____________ = _______________

(Total Revenue) (Total Cost) (Profit: +/-)

Round 4

Revenue:

__________ x __________ x $5 = __________

(Number of Pots) (Lobsters per Pot) (Total Revenue)

Costs:

__________ x $50 = __________

(Number of Pots) (Total Cost)

Profit:

__________ - __________ = __________

(Total Revenue) (Total Cost) (Profit: +/-)

Round 5

Revenue:

__________ x __________ x $5 = __________

(Number of Pots) (Lobsters per Pot) (Total Revenue)

Costs:

__________ x $50 = __________

(Number of Pots) (Total Cost)

Profit:

__________ - __________ = __________

(Total Revenue) (Total Cost) (Profit: +/-)

Total Gain or Loss from Fishing:

Add up the total profits from all of the rounds (make sure to include the sign, if they were negative).

Profit Round 1: __________

Profit Round 2: + __________

Profit Round 3: + __________

Profit Round 4: + __________

Profit Round 5: + __________

Total Profit = __________

No Fish in my Dish

Goal:
- Students become familiar with the tradeoffs that exist between conservation of a resource and use of that resource and gain an awareness of the way that humans impact marine habitats.

Objectives:
- Students are able to list at least three ways in which humans negatively impact their habitat.
- Students are able to list at least three ways that humans can help to improve the marine environment.

CA Standards:

Science

3.3.c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

3.3.d. Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

Social Studies

3.5.1. Describe the ways in which local producers have used and are using natural resources, human resources and capital resource to produce goods and services in the past and in the present.

3.5.3. Understand that individual economic choices involve trade-offs and the evaluation of benefits and costs.

Reading Comprehension

2.3 Demonstrate comprehension by identifying answers in the text.

2.4 Recall major points in the text and make and modify predictions about forthcoming information.

2.5 Distinguish the main idea and supporting details in expository text.

2.6 Extract appropriate and significant information from the text, including problems and solutions.

National Standards:

Science

NS.K-4.6 Personal and Social Perspectives

FOSS Kit Modules:

Environments
Structures of Life
Food and Nutrition

Materials:
- "No Fish in my Dish" by Jason Kelly story (provided)
- "No Fish in my Dish" worksheet (provided)
- Character Summaries for mock debate (provided)

Set-up:

- Make one copy of "No Fish in my Dish" worksheet for each student.
- Make one copy of the Character Summaries. Then cut along the dashed line creating individual strips.

Procedure:

Introduction (10 minutes)

- Remind the student's that they have had experience looking at habitats that have been negatively affected by humans – the trash that they helped to pick up on their streets.
- Tell them that litter is not the only way that humans can have a negative impact on their environment. Ask the students to think of some others. *Potential answers include: pollution, climate change, destroying habitats, fire, diverting rivers, etc.*
- Now tell the students that they are going to listen one person's story about how humans have impacted the community.

Main Activity (20 minutes)

- Have the students gather together. Tell them that you are going to read a story called " No Fish in my Dish". Tell them to pay careful attention because there will be questions that they need to answer afterwards.
- Read the story.

Conclusion (30 minutes)

- Remind the students how in the story some people were in favor of the no-take zone and some who weren't. Tell the students that the people against it don't hate the environment, they just are concerned with making a living and supporting their family. For some fishermen this is the only way they know to earn money.
- Tell the students that in order to demonstrate how difficult this situation can be tell them that they are going to participate in a mock-debate.
- Tell the students that they are all residents of a hypothetical town that is trying to decide whether to implement a no-take marine sanctuary. There are people in the town that are in favor of it and there are people that are against it.
- Hand each student a character from the pre-cut Character Summaries. Tell the students that this is their persona. They are going to become this character, with their concerns. Remind students, that they don't have to agree with their character, but they do need to portray that character accurately-like and actor/actress.
- Give the students a few minutes to read over their persona and answer any questions they may have regarding their character.
- Now tell the students that they will take part in a town council meeting. You will be the moderator, periodically calling on different students to give their opinion of the proposed no-take marine sanctuary. Make sure that everyone gets a chance to speak. Remind them that they are trying to sway the potential voters to see their side of the story and vote the way that they would.
- At the end, have a closed ballot vote to see if the town passed the no-take marine sanctuary.

"No Fish in my Dish" by Jason Kelly

We live by the sea where Daddy fishes each day
Mommy packs lunch then we walk him to the bay.
His boat is a small one; he says it's a she,
so he named her "Darling" after Mommy and me.

Daddy and Darling catch lots of fish.
He learned from Granddaddy some tricks that don't miss.
"You go where the plants and the little fish play,
then you wait for the big fish, 'cause that's where they stay.

Another tried-and-true from my bag of fish tricks
is to go where the warm and the cold water mix.
You throw one hook, then a hundred, or two hundred, or three!
That's how you catch lots of fish from the sea."

And that's what Daddy's done for all of his life.
He says it's a way to feed his daughter and wife.
At night he comes home and says, "Make a wish!"
Then I say, "Please put a fish in my dish!"

He walks to the table, sets down his cooler,
I roll out newspaper, Mommy gets the ruler.
He says, "I have one fish. No, two fish. No, three!
A small one for Baby, a big one for Mommy, and the biggest one for me."

Mommy starts cooking. Daddy takes a bath.
I set the table with three place mats.
He walks to the kitchen, gives me a wink,
then kisses Mommy while she works at the sink.

Oh, I feel happy 'cause I'll soon get my wish!
Mommy comes to our table with the skillet of fish.
She serves the small one, the big one, and the biggest one, too.
She says thanks to Daddy; he says, "No, honey, thank you."

After dinner, Mommy rests as I wash the dishes.
We make such a mess eating Daddy's fishes!
We each brush our teeth and lie down in our bed.
On Daddy's strong chest I lay my head.
He takes a deep breath to speak to the world:
"Goodnight all you fishes, my sweet wife, my little girl."

That was pure happiness as far as I knew.
Every night there were three of us, by day just two.

The fish lived in the sea and we lived on the land
and every dinner was fish that Daddy caught by hand.

But it all started changing, not right away,
just a little something different each day in the bay.
"There's a new kind of boat," Daddy said, "made of steel.
Ten men work the deck, another stands at the wheel.
Every time I catch one fish, that boat catches twenty.
They sell all those fish and make lots of money."

At first it was one boat, then hundreds, then more.
When we walked by the bay we could not see the shore.
It used to be few boats, here a dot, there a dot.
But slowly the bay became a boat parking lot.

Then Daddy came home one night in July.
His face looked so different I wanted to cry.
"Don't make a wish," he said, his voice low and blue.
"I know what you'll wish but I can't make it come true.
Darling worked hard and your daddy tried, too,
but tonight, little Baby, I've no fish for you."

"No fish?" I cried. "How can that be?
I thought there were billions of fish in the sea.
Their colors of blue, yellow, violet, and green,
with big ones for Mommy and small ones for me.
Even Granddaddy says there are more fish than we see.
That's why you throw hooks by two hundred or three."

Daddy put a hand on the back of my head.
"I know what you mean and what Granddaddy said.
But if millions of people throw hundreds of hooks,
then someday we'll have taken all to be took.
It might be just here, it's too soon to say.
So tomorrow I'll take Darling far outside the bay."

The next day they went farther than ever before,
but that night, with no fish, he walked in the door.
Mommy cooked his favorite vegetables and whistled a song.
She tried to help him forget that something was wrong.
He said he would not come home the next day
because he and Darling must go farther away.

They were gone first one night, then two nights, then three.
Every night at the table sat just Mommy and me.
At last he came home with one fish in his rig.

It was a small one, but the kind that used to be big.

"I threw my hooks and my lines, all that could be thrown,
to find this one small fish, swimming alone."
He pointed to the cooler and we all looked inside
to see the one small fish swimming, still alive.
"I don't want to eat her," Daddy said next.
"She might be the last fish that I ever catch."

He put an arm around Mommy and one around me
and said, "Soon there will be no fish in the sea.
A sea without fish is no sea at all.
It's just water and darkness and small things that crawl.
It's like a tree with no leaves or the sky with no sun,
like a man with no family, like a dog that can't run."

"It makes me sad," Mommy sighed. "Me too," Daddy replied.
I didn't say anything. I just cried.

The fishermen meet every fourth Saturday.
A fisher stands at the front if he has something to say.
Daddy had something to say, all right.
He wrote out his comments and practiced Friday night.

On Saturday morning he took Mommy and me
to Fishermen's Hall where it was quite plain to see
that the neighborhood fishers and local bait floats
had been mostly replaced by ten-man steel boats.

Daddy stood at the front without using his notes
and said, "There's a problem with ten-man steel boats.
They catch too many fish and they do it too fast.
The big schools of fish are a thing of the past.
We must catch fewer fish—immediately—
or soon we'll find no fish in the sea."

The leader of the meeting listened and wrote,
but he was the owner of a ten-man steel boat.
He looked up at Daddy, cracked his knuckles, one, two, three.
I could tell by his face that he did not agree.
"What are you saying, no fish in the sea?
Is that crazy to anyone else, or just me?
My family has fished in the ocean forever.
Why should I stop because we've gotten better?"

Another man stood. "The boss is right.

There are plenty of fish, no end in sight.
For years we've tried finding a better way.
These ten-man steel boats are here to stay."

Another man stood. "Catching fish is not bad.
Why I think there are even more fish to be had.
With a bigger boat and gigantic net,
we'll catch millions of fish, all we can get."

"And a new kind of boat," said the leader of the meeting,
"brings a smile to my face and gets my heart beating.
It drags a strong net along the seafloor.
That's a wonderful way to catch even more."

Daddy said, "This is not what I wanted to hear.
The more I listen the more I fear
that we won't slow our fishing until it's too late,
after every last fish has been served on a plate.
And these new nets you like, they'll catch fish and more.
You'll drag sea lions and dolphins and turtles to shore."

Then Daddy stopped talking. He just looked around.
Nobody smiled. Everybody frowned.
Daddy said, "This is hopeless. I see it on your faces.
Any change that can come will have to come from other places."

The men started shouting and jumped to their feet.
They said things to Daddy that I will not repeat.
He pushed through the crowd to take Mommy's hand and mine,
and we rushed out the door into the sunshine.
We walked around the bay, we smelled the sea foam,
we felt a little better by the time we got home.

Daddy's cooler still sat on the kitchen floor
to the left of the table, behind the door.
That one small fish that he had found
still lived in the cooler, swimming around.

"She's lovely," Mommy said. "She belongs in the sea.
That's where she'd be if it were up to me."
"We all feel that way," Daddy nodded and said.
"But in that boat-filled sea she'd just end up dead."

Then Daddy got angry. "It's all those boats in the bay!
They catch thousands of fish day after day!"
Mommy put her finger across Daddy's lips.

"They're part of the problem, but it's not just those ships."

She walked through the kitchen and stood by the stove.
"This is the biggest problem, you know.
You catch the fish, but I cook them here,
and I did it three hundred sixty five days a year.
Millions of people catch billions of fish
because billions of people want a fish in their dish.
Once in a while would be OK,
but we billions of people want a fish everyday.
You might hate the boats, but give it some thought.
They only catch fish because the fish get bought."

We all stood, thinking. The kitchen grew quiet.
The longer we thought, there was no getting by it.
"It's simple," Daddy said. "Eat more, have less.
We ignored that simple and made this mess.
We have to do something before it's too late.
Let's find an idea that's easy but great."

I looked at the stove, I looked at the sink,
I looked at the table, and continued to think.
"It's a lot like the seesaw at the park in town.
When one side's up, the other is down.
If we eat fewer fish, the more there will be.
It's an easy, great idea, Daddy, don't you agree?"

For the very first time in a very long while,
Daddy's face relaxed and spread into a smile.
"Yes, that's the answer. Yes, I agree.
We'll eat fewer fish and leave more in the sea.
For five days a week we'll have something else to eat,
maybe vegetables and bread, fruit salad or meat.
The fish will have time to have babies and then,
slowly the oceans will fill up again."

Mommy said, "Let's start here and let's start today.
We'll show everybody there's a different way.
We'll tell our friends and our family and our neighbors, too,
about this idea that's easy to do."

Then life changed quickly for my family and me.
Fruit ripens slowly but falls suddenly.
Mommy made a cookbook of no-fishes dishes
and for five days a week they satisfied my wishes.
Daddy met people who work hard to save fish.

He asked for ideas and they told him this:
"A no-take zone is a very good way
to give some fish a safe place to stay.
If you find a place and are willing to try it,
our people and money will help you supply it."

He found a section of the bay just right
to keep boats away every day and every night.
With his new team of friends he got started right away.
He became a fish protector and is still one today.

There was one person left in our family of three.
Telling other people was left up to me.
I wrote on papers that I took door-to-door.
When I used all the papers, I went home and wrote more.
Our neighbors and friends were very nice to me
as I told them the plight of the fish in the sea.
They said, "My goodness,"and asked what they could do.
I said, "Funny you should ask, I was about to tell you.
My idea is simple, even childish,
but for five days a week say, 'No fish in my dish!'
The fish will have time to have babies and then,
slowly the oceans will fill up again."

They liked my idea, they liked it a lot.
Some said, "OK,"others gave it some thought.
After a while, my idea took hold
and week after week fewer fish were sold.

There was no longer a reason to catch millions of fish
because so many people said, "No fish in my dish."
The giant steel boats with their nets and their lines
slowed down their fishing with the changing times.

And how 'bout that fish in Daddy's cooler, alive?
She went to Daddy's zone where she swam and thrived.
She was the fish that had started it all.
She called out to our family and we heeded her call.

One night over dinner -with a no-fish dish-
Daddy said maybe there was something we missed.
"Our town heard us quickly and saved fish in our bay,
but what about all the good towns far away?
Let's take this story to those people, too,
so they know the problem and see what to do."

Telling other people was still in my hands.
How to get the story to faraway lands?

"I'll just write it," I thought, "in words that rhyme.
And I'll keep it short so it takes little time.
I'll put copies in bottles every single day,
tie the bottles to fish that swim far away."
So that's what I did, it was all I could do,
to get this easy, great idea from me to you.

Here you go, friend. Here is my wish:
For five days a week, say,

"No fish in my dish!"

Character Summaries

Charlie, the fish monger. As the fish monger, you receive all the processed fish and try and sell them to stores and individuals. You are worried that the implementation of the no-take marine sanctuary will affect your business – if there are no fish being caught, there are no fish for you to sell.

Bailey, the commercial fisherman. You have been a fisherman for decades. Your father was also a fisherman as was your grandfather before him. You do not know any other way to make an income then from fishing in the bay. You are worried that the no-take marine sanctuary will force you out of a job and you will no longer be able to feed your family.

Alex, the boat mechanic. You don't really care for fish, but your main customers over the years have been fishermen. 90% of your income comes from repairing fishing vessels. You are worried that the implementation of the no-take marine sanctuary will cause you to lose almost all of your customers.

Chris, the harbormaster. You are unsure about how this no-take marine sanctuary will affect you. Currently you work down at the harbor with all the fishermen. They are your friends and you would hate to see them lose their jobs. However, it is very hard work trying to work with all of them. The marine sanctuary would get rid of the fishermen, but might bring in other types of business.

Cameron, the fish processor. After fishermen catch the fish, they must bring the fish to you to be processed. You are the only fish processor in town and have made a good living working with the fishermen. You are worried that the no-take marine sanctuary will force you out of the business.

Casey, the seafood restaurant owner. You own the best seafood restaurant in town. It is written up in all the travel magazines and people come from far away to eat the seafood in your restaurant. The seafood is what the people come for, so you worry that the no-take marine sanctuary will result in less fish and less customers coming to your restaurant.

Devon, the commercial fisherman. Like Bailey you have been fishing for years. You just purchased a brand new boat to go fishing in, and will be paying it off over the next 10 years. You need to keep fishing in order to pay of the boat, so you worry that the no-take marine sanctuary will force you to bankruptcy.

Jamie, the aquarium director. You are excited about the possibility of the no-take marine sanctuary. It is getting harder and harder for you to find healthy fish to display in your tanks, so the sanctuary could really help out your business.

Jesse, the tourism director. A no-take marine sanctuary could really boost tourism in the town. If the water became cleaner and the fish came back there would be all kinds of opportunities to take tourists out kayaking, snorkeling, scuba diving, sailing, and whale watching.

Drew, council member. You have served on the council for at least a decade. The fishing industry is your biggest supporter, they have gotten you elected over and over again. Fishermen have been coming to talk to you about their anxiety regarding the proposed no-take marine sanctuary and have hinted that if it passes they will not vote for you in the next election.

Taylor, recreational fisherman. The idea of the no-take marine sanctuary annoys you. All fishermen will be denied access, even you. The decline in fish is not your fault-it is the commercial fishermen. You only go fishing a couple times a year, but really enjoy it as a mini-vacation. You should not be punished for the actions of others.

Blake, owner of the bait shop. For years you have run the bait shop supplying fishermen with all the bait, nets, fishing line, etc. that they needed. If the no-take marine sanctuary is implemented then you will lose you best customers and probably go out of business.

Erin, Mayor. You were just elected mayor. You are unsure whether to support the no-take marine sanctuary. If you support it, you will lose all the support of the fishermen, but will gain the support of the tourism industry. If you don't support it, the bay will stay polluted and most of the fish may die.

Jackie, Coast Guard employee. The implementation of the no-take marine sanctuary has pros and cons for you. On the up side, you won't have to keep going out to rescue the fishermen- they often go out in really bad weather because they need to earn a living. But, on the down side, you will be expected to help enforce the new no-take marine sanctuary, which will make you unpopular in town.

Lee, avid recreational diver. You are really excited about the new no-take marine sanctuary. You love to go scuba diving and will now be able to go out in the sanctuary and see all kinds of things that you have never seen before – things that were previously overfished by the fishermen.

Nicki, water quality specialist. You feel the implementation of the no-take marine sanctuary will be a good idea. Currently the water is dirty with all the pollution coming from the fishing boats and getting them off the water will give the environment time to recover.

Quinn, fish biologist. Fish populations are way too low! The no-take marine sanctuary is necessary to help save the bay and all of the animals that live there. Implementation of the sanctuary will help the fish populations and all other organisms living there.

Riley, conservationist. Fishing is hurting the ecosystem of the bay. It causes pollution and kills off fish faster then they can make babies, so the population is declining. The best thing to do to conserve this resource is implement the no-take marine sanctuary. It will safe animal lives!

Robin, snorkel operator. The idea of the no-take marine sanctuary excites you! You don't get a lot of tourism business to go snorkeling in the bay because it is dirty and the customers don't see a whole lot of fish. The sanctuary will make the bay a much more attractive place to take your customers.

Sammi, marine sanctuary employee. You have recently moved into town after working at a marine sanctuary farther up the coast. You think that the no-take marine sanctuary worked well at the last place you lived, and are hoping that if it gets implemented that they will hire you as an employee.

Ocean Acidification

Goal:

- Students are able to understand the consequences of ocean acidification on various marine organisms.

Objectives:

- Students are able to name at least one marine organism that will be negatively affected by ocean acidification.
- Students are able to list at least one source of increased CO_2 in the atmosphere or oceans.

CA Standards:

Science

3.3.c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

3.3.d. Students know when the environment changes, some plants and animal survive and reproduce; others die or move to new locations.

3.5.d. Predict the outcome of a simple investigation and compare the result with the prediction.

3.5.e. Collect data in an investigation and analyze those data to develop a logical conclusion.

Writing Applications

3.2.2. Write descriptions that use concrete sensory details to present and support unified impressions of people, places, things, or experiences.

National Standards:

Science

NS.K-4.1 Science as Inquiry
NS.K-4.3 Life Science

Materials:

- Vinegar
- Eye Dropper (spoons can work if students are careful)
- Variety of shells, calcareous algae, sand, etc. collected from beach
- Magnifying glasses (the more the better)
- 4 Shallow dishes (petri dishes are ideal if you have them)
- Bubble Snail Blues worksheet (provided)

Setup:

- Collect a variety of different shells, sand and encrusting algae from the beach (enough for four groups)

- Divide shells into four different groups
- Put one of the four dishes at each student desk cluster
- Distribute magnifying glasses to student cluster
- Give each group about ¼ cup of vinegar
- Make copies of Bubble Snail Blues worksheet (1 per student)

<u>Procedure:</u>

Introduction (25 minutes)

- Explain to students that they are going to perform an experiment on some shells. Tell the class that humans have caused some problems in the oceans, ask them to list a few. *Potential answers include: pollution, marine debris, loss of habitat, overfishing, climate change, etc.*
- Ask students if they are familiar with climate change. If not explain that temperatures in most parts of the world have been and will probably continue to increase over time. While climate can change due to normal fluctuations, this change is primarily human driven. Tell the students that it is the result of humans burning fossils fuels and releasing carbon dioxide (CO_2). Ask students for examples of fossil fuels. *Answers include: oil, coal and natural gas.* Remind students that burning fossil fuels releases CO_2 into the atmosphere and increases in CO_2 lead to increases in the Earth's temperature.
- Ask students if they can list anything that releases CO_2 through the burning of fossil fuels. *Potential answers include: cars, buses, planes use oil; heating, cooling, electricity and other energy demands use natural gas and coal; etc.*
- Explain to students that the amount of fossil fuels humans are burning is increasing every year and therefore the temperature is increasing every year.
- Tell the students that in the oceans, climate change not only raises the temperature of the oceans, but also raises the acidity. So the ocean is becoming more acidic. Ask students if they are familiar with acids. Scientists define acids as substances that have a pH less than 7. Tell the class that they are already familiar with acids since they are corrosive or bitter tasting substances such as lemon juice, lime juice, orange juice, coffee, battery acid, and vinegar.
- Ask the students if they think that this increase in acidity will be a problem. Ask the students if they think an increase in the acidity of the ocean will have an effect on some of the animals that live there.
- Tell the class that they are going to observe some of the impacts that a more acidic ocean could have. Pass out the various shells and other beach items to each table group. Have them guess which items will probably be most affected by a rise in acidity.
- Next pass out the shallow dishes, the vinegar, eyedroppers and the magnifying glasses. Tell the students that they will put one shell, grain of sand, or piece of algae at a time in the dish. Then they will put a little acid on the shell with the eyedropper (or spoon). Tell them to use about a teaspoon each time, show them the appropriate amount.

- After the students have put the acid on their items, have them look at each of them through the magnifying glass. Explain to the students that they are looking for little bubbles forming around the edges – tell the students that they will have to look carefully. These bubbles mean that the acid is dissolving the shell, etc.
- Have them repeat the exercise for the various items they have, even the sand. Have them note which ones are affected the most. Also have them note what happens when some are left immersed in the vinegar (this is especially good for a calcareous red algae, since it will break apart and dissolve somewhat quickly.
- After students have finished, have them clean up.

Main Activity (20 minutes)

- Tell the students that the oceans will probably never be as acidic as the vinegar, so the effects will not be that dramatic. However, scientists are still very concerned about increase in acidity and are just beginning to study it. One such study is being conducted in San Diego at the Scripps Institution of Oceanography. Scientists there are researching the effects of an increase in acidity on bubble snails, a small, shelled mollusk found in the area.
- Tell the students that they are going to get the opportunity to become scientists as they hypothesize about the fate of the bubble snail with an increasingly acidic ocean.
- Pass out Bubble Snail Blues worksheet. Give students about 10-15 minutes to complete it.

Conclusion (10 minutes)

- Have students share some of their answers from Bubble Snail Blues.
- Tell the students that it isn't just invertebrates that are affected by the ocean becoming more acidic. It will most likely have an effect on all organisms in the ocean, from the smallest up to the largest.
- Ask students if there is anything they could do to help stop ocean acidification. Answers should focus on reducing energy consumption and transportation. *Potential answers include: turning off lights, carpool, walk, ride bikes, skateboards, etc.*

Name: ______________________________ Date: ________________

Bubble Snail Blues

1. With increasing acidity the Bubble Snail becomes increasingly fragile. While the shell may never break, why could this be a problem for the snail?

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2. Navanax love to eat bubble snails, will a more fragile shell make it easier for them to eat them?

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3. Over time, will the bubble snail population increase or decrease? Why?

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4. Over time, will the navanax population increase or decrease? Why?

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____

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5. Do you think that this problem will only affect bubble snails? What other organisms could it affect?

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6. Write a letter from the perspective of the bubble snail explaining the problems of ocean acidification. Try to describe some things that humans could do to help.

Ocean Awareness

Goal:

- Students gain letter-writing experience by writing to a political figure about the problems of marine debris.

Objectives:

- Students are able to list at least three marine animals that are affected by debris.
- Students are able to identify the important components necessary when writing a letter.

CA Standards:

Science

3.3.c. Students know living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

3.3.d. Students know that when the environment changes, some plants and animals survive and reproduce, others die or move to new locations.

Reading Comprehension

3.2.5. Distinguish the main idea and supporting details in expository text.

3.2.6. Extract appropriate and significant information from the text, including problems and solutions.

Writing Applications

3.2.3. Write personal and formal letters, thank-you notes, and invitations.

National Standards:

Science

NS.K-4.6 Personal and Social Perspectives

Materials:

- Animal Letters (provided)
- Piece of paper (1 per student)
- Envelope (1 per student)
- Pencils

Setup:

- Look online for the address of a local politician for students to write to.
- Make copies of the Animal Letters
- Have enough envelopes for envelopes for every student. If you don't want students to individually write out envelopes have a big manila envelope to mail them all in.

Procedure:

Introduction (10 minutes)

- Ask the students what are some ways that they can pass on a really important message. *Potential answers: write a letter, write an email, write a newspaper article, write a song, have a meeting, have a protest, have a demonstration, etc.*
- Tell students that there are many things that are harmful to the ocean, but unfortunately it is difficult for the animals and the ocean to tell us about it.
- Ask the students what they think are some of the problems facing the ocean. *Potential answers include: pollution, marine debris, increased boat traffic, overfishing, dredging, loss of habitat, etc.* Briefly discuss each.
- Tell the students that today they are going to get learn about one of the problems facing the animals in the ocean – marine debris, which is trash in the ocean. Marine debris refers to all forms of trash that have accumulated in the ocean. The majority of this trash comes from sources on land. The debris then moves through storm drains out into the ocean. The debris can get trapped in ocean currents and forms large garbage patches in the ocean. One such patch is referred to as the Great Pacific Garbage Patch and is estimated to be twice the size of Texas.

Main Activity (45 minutes)

- Explain to students that they will be reading some letters written by some invertebrates that live in the ocean. The letters will focus on some issues these organisms are facing. Pass out the Animal Letters. Have the students read over them, focusing on both the content and the format.
- After the students have read them all, tell them it is now there turn to carry the message on to some adults in charge. Ask students to remember some of the ways they said really important messages could be passed on.
- Tell the students that they are going to write a letter to one of their local politicians (congressmen, senator, representative, etc.) about the problems that marine debris causes in the ocean.
- Have them brainstorm some of the key points, which should be included in the letter. If time permits give them time to do some additional research.
- Review the key components of the letter: date, proper salutation, body, closing and signature.
- Have students write their letters.

Conclusion (10 minutes)

- Have students share their letters.
- Ask them why writing a letter to their politician would help. Tell them that politicians have the ability to pass laws that can protect the environment. For example, the city of San Francisco has banned plastic bags. The city of Seattle banned plastic water bottles.
- Ask the students to brainstorm some laws that could potentially help animals from marine debris.

- Local politician's addresses can easily be found on the internet. Research local politician in your area and have the students send them letters.

Animal Letters

February 8, 2007

Dear Student,

I lead a very active life. I will fly for miles and miles looking for something that catches my eye in the ocean. I even look in the piles of seaweeds that wash up on the beach or steal food caught by other animals. I especially like to eat round, clear fish eggs.

Unfortunately, as I search I see lots and lots of trash floating in the ocean. Over the years there seems to be more and more of this debris. I even flew over a huge field of it in the ocean that scientists are calling the Great Pacific Garbage Patch. It is twice the size of Texas!

This is a problem since occasionally I pick up some brightly colored pieces of plastic and eat them. I will even feed these pieces to my chicks. I also know my friends have been doing the same thing and this has lead to a large increase in seabird deaths. Please help!

Sincerely,
Albatross

August 17, 2009

Dear Student,

I may not be the fastest swimmer in the ocean, but I cover thousands of miles of ocean in my lifetime. In doing so, I have noticed a lot of trash accumulating. I swim past bottles and bags, cigarettes and cans, straws and strings. Most of it is barely visible, because it sinks just below the surface.

One reason that I am concerned about this is I see other turtles struggling; they get tangled up in large pieces of trash, especially abandoned fishing nets. Sometimes this marine debris gets so heavy it can interfere with swimming.

Another major concern is that the plastic bags floating in the ocean resemble some of our favorite food – jellyfish. Turtles eat them and then end up suffocating or starving to death. Please do something to help us!

Sincerely,
Leatherback Sea Turtle

December 18, 2008

Dear Student,

We are in big trouble down here. Not only are we overfished by big boats, but we are being captured in nets not attached to boats. They are called "ghost nets". What happens is the nets are lost off the big fishing boats, and because the nets are made of plastic they don't degrade in the ocean, so even when not attached they keep fishing. No amount of swimming can get you away from them, since they are all over the oceans.

These ghost nets float along capturing fish and other organisms. Once they get full and heavy they sink to the bottom taking all the animals with them, killing them. I've even seen turtles, mammals and birds in these nets. Over time these dead animals break apart and slowly the net becomes lighter. The net then starts to float again where it catches and kills more animals. Help is needed not just for all of us fish down here, but for all marine life.

Sincerely,
Jack Mackeral

April 30, 2005

Dear Student,

It is not an easy being a coral, many people think we are just rocks, but in fact we are animals who live with plants. We need just the right temperature, salinity, sunlight, nutrients and so on. It is becoming harder now with the accumulation of all this marine debris in the ocean. Big pieces of nets and other plastics become tangled up on our reefs. They can break big chunks off and make it hard for us to photosynthesize.

If that weren't bad enough, the plastic never goes away! It may break down into smaller and smaller pieces, but it never goes away. And the small pieces look like my favorite food – plankton, the little guys floating in the ocean. These little plastic bits then continue to accumulate in the bodies of anything that eats plastic or eats an animal that eats plastic (like plankton).

All the ocean's animals need your help. I may have a mouth, but I can't speak, so I need you to contact anyone that you think can help us with this problem. Help find a solution to the marine debris problem.

Sincerely,
Elkhorn Coral