

**Marine Science Institute
Post-Discovery Voyage
Educator Guide
for Grades 5-6**



Post-Discovery Voyage Educator Guide for Grades 5-6

Written by Andrea Swensrud

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Marine Science Institute Post-Discovery Voyage Educator Guide

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How to Use the Lessons

The ten lessons contained in this guide are meant to be used as a follow-up to a Discovery Voyage field trip. They are designed for 5th and 6th grade students and are aligned with California State Content Standards for those grades. They may, of course, also be adapted for use with older and younger students. The lessons may be used all together immediately after your Discovery Voyage in a unit on the San Francisco Bay or marine ecology, or they can be used throughout the year as they fit into your curriculum to continuously reinforce concepts your students learned on the trip.

The lessons are organized based on the main topics covered on the Discovery Voyage. The following table also shows with which subjects they are aligned in regards to California State Content Standards.

	English- Language Arts	Math	Science
General:			
• Translating the Tides	✓		
• Whose Home on Bair Island?	✓		
• Piecing Together a Food Web			✓
Hydrology:			
• The Color of Salt			✓
• A Long Journey			✓
Plankton:			
• Drifting Delicacies			✓
• Diatom to a Dime		✓	
Invertebrates:			
• Who Needs Mittens?	✓		
• Invent an Invertebrate			✓
Fish:			
• Making Sense of it All		✓	

Lesson Format

California State Content Standards

Lists the California State Content Standard for which the lesson is aligned for both 5th and 6th grades.

Lesson Objective

What the students will accomplish as a result of completing the lesson.

Materials

Supplies needed to complete the lesson.

Time

An estimate of the time it will take for preparation, completion of the lesson, and clean up. The lesson time may be different depending on the level of the class.

Background

Information that is relevant to the lesson. It may be a short review of what the students learned on the Discovery Voyage. Occasionally, it may be necessary to share this information with the students in order for them to complete the lesson.

Method

Step-by-step instructions for completing the lesson.

Assessment

Presents questions to answer when reviewing the students' works to see if they clearly met the lesson objective and content standard.

Resources

A list of resources used to create and/or write the lesson.

Options

Suggests other ways that the lesson can be completed or extended. Not all of the lessons list additional options.

Translating the Tides

California Content Standards

Grade 5- Language Arts, Writing 1.0. "Students write clear, coherent, and focused essays..."
Grade 6- Language Arts, Writing 1.2b. "Students will develop the topic with supporting details and precise verbs, nouns, and adjectives to paint a visual image in the mind of the reader."

Lesson Objective

Students will write an essay, short story, or poem about any aspect of the Bay that they learned about on the Discovery Voyage.

Materials

- Paper
- Pencils
- Chalkboard and chalk

Time

Preparation: Two minutes

Lesson: Forty-five minutes

Clean Up: Two minutes

Background

After completing a Discovery Voyage, you will receive information on how to thank your sponsor as well as information on MSI's poetry contest, "Translating the Tides." The Marine Science Institute would like each class to submit poems, essays, or short stories to their sponsor showing what they have learned on the voyage. The poems may also be entered into the contest. The goal of the writing activity is for students to think creatively about their experience and demonstrate their new knowledge through writing.

Method

1. Discuss as a class the students' experience on the Discovery Voyage. What were their favorite parts? What did they learn about that they didn't know before? Was there a particular organism that really interested someone?
2. Make a list of words on the chalkboard from the Discovery Voyage that mean the most to the students. They may be names of animals, descriptive words, activities, or facts.

3. Now have the students brainstorm to create their own lists. When they are complete, ask the students to circle the words that most interest them.
4. From the circled words, each student should choose one to be the subject of their poem, story, or essay. Students should think about how they would describe their chosen subject to someone who had never experienced or seen the Bay. What would they want someone to feel or understand? Why is it special?
5. Have the students brainstorm to make another list of words that describe the subject of their poem or story.
6. From these lists, students may begin to write. Poem, stories, and essays should be creative and descriptive. Rhyming is not necessary.

Assessment

Did the students write clear, coherent, and creative poems, essays or short stories? Did they use details to create a visual image of their subject for the reader?

Resources

Lesson adapted from Marine Science Institute's "Translating the Tides" poetry contest.

Translating the Tides

...A poetry contest through the Marine Science Institute

Show us the Bay through your eyes! Enter a poem that makes the Bay come alive, and you could win one of the following prizes:

1 st prize:	\$150
2 nd prize:	\$100
3 rd prize:	\$50

Our six age groups are: K-3, 4-5, 6-8, 9-12, College, and

*Adult (Chaperone)/Teacher

*Adults and teachers are encouraged to submit poems as well! They will not receive cash prizes, but their work will be featured in the collection.

On your submission, **please include in the upper right-hand corner of your paper:** your name, grade, school, funder, and the date of your program. Please use 8 ½x11 paper. **Deadline is August 31st.**

All contest winners & honorable mentions will find their work printed in a collection that is available each year in January!

Here are some suggestions for getting started:

Step 1: Discuss your program experience with a group or partner for 10 minutes. Take notes on the things that stand out most in your mind.

Step 2: Circle the words that mean the most to you and make a list of them. What will be the main idea of your poem?

Step 3: Ask yourself: how would you describe the main idea of your poem to someone who had never seen the San Francisco Bay? What do you most want them to feel and understand? (Suggestion: This poem is not judged on rhyme, we actually prefer poems that don't rhyme! We look for clues that show us you understand what you've learned, and you want others to know something special about it).

Questions about the contest? Call MSI at (650) 364-2760

Whose Home on Bair Island?

California Content Standards

Grade 5- Language Arts, Speaking Applications 2.2. "Students deliver informative presentations about an important idea, issue, or event..."

Grade 6- Language Arts, Speaking Applications 2.4. "Students deliver persuasive presentations."

Lesson Objective

Students will create and present a persuasive argument for or against proposed development of Bair Island.

Materials

- Paper
- Pencils
- Copies of the Bair Island Fact Sheets included in this lesson

Time

Preparation: Two minutes

Lesson: Suggested for completion over two days.

- Group Preparation: One hour
- Presentations: One hour, ten minutes

Clean Up: Two minutes

Background on Bair Island

Bair Island is on the opposite side of Redwood Creek from the Marine Science Institute. It once included thousands of acres of unspoiled tidal salt marsh, tidal sloughs, and mudflats until portions of the area were diked in the late 1800s. Bair Island acquired its name from Fred Bair, who lived on the outer island in the 1920s where he harvested oysters and raised cattle. Leslie Salt purchased the land in the 1940s and built levees that divided the island into three sections: inner, middle, and outer Bair Island. Leslie Salt used the island for salt evaporation ponds until the 1960s. In 1973, Leslie sold Bair Island to Mobil Oil Estates, Ltd. Mobil donated half of the outer island (about 800 acres) to the state wildlife refuge, but also filed plans to build "South Shores," on inner and middle Bair Island. The South Shores development called for 20,000 homes, a shopping center, and 4 million square feet of corporate office space. Redwood City Council approved the plans for development, but a coalition of Redwood City residents, called "Friends of Redwood City," led by Ralph Nobles, gathered enough signatures on a petition

to force a vote. In 1982, Mobil's plan was defeated by only 42 out of 17,900 votes in a referendum, "Measure O."

In 1989, Tokyo-based developer Kumagai Gumi purchased Bair Island from Mobil. Kumagai had interest in developing the island in 1997, however other people had different ideas. In the interest of returning Bair Island to its natural state, Peninsula Open Space Trust (POST) started fundraising in order to purchase the land. By March 1999, POST had raised \$5 million. When added to federal and state funds already in place, the cumulative contributions equaled \$15 million- enough to buy the final 1,626 acres of Bair Island. The Don Edwards San Francisco Bay National Wildlife Refuge now manages Bair Island's 2,600 acres of marsh. Recently, parts of Bair Island have undergone restoration: sloughs have been dredged and landfill has been removed. However, it will take years for the island to completely return to its natural state.

Although for decades a large portion of Bair Island was used for salt evaporation ponds, the island as a whole remains one of the most valuable wildlife areas in the South San Francisco Bay region. Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish. Included in this count are at least four rare and endangered animals: California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican. The island also contains the South Bay's only harbor seal rookery.

Method

1. Tell the students that they will be working in small groups to create and present an argument either for or against a development project around the Bay that will then be voted on as a class. The issue that they will be learning about was a real matter that caused the government, corporations, and citizens of Redwood City to battle against each other.
2. Review the requirements for a persuasive presentation: a clear statement of position, a logical sequence of information, engagement of the listener, and relevant evidence including facts, details, examples, and explanations.
3. Introduce Bair Island and its history to the students using the background information above. Stop after you tell them that Mobil had filed plans for "South Shore." Explain that the planned development was put on the ballot as "Measure O" for the citizens of Redwood City to vote on.
4. Tell the students that they will role playing as a member of a group that has an interest in whether or not the South Shore project should be

approved. Each group will be giving a 5-minute presentation at a mock City Council meeting about their stance. The seven groups are: Mobil Oil Estates, Ltd., Redwood City Council members, shop owners in Redwood City, Marine Science Institute, the local construction union, Redwood City residents, and Peninsula Open Space Trust. Each group will receive a card with more information on their group as well as some facts about Bair Island. Explain to the students that as a member of a certain group, they may have to argue and represent views that are not actually what they truly believe.

5. Tell the students that they will be given time that day to prepare their arguments either for or against the development of Bair Island. The next day each group will be giving their 5-minute presentation to the rest of the class in the mock meeting. Every student should have an active speaking role during the presentation. They may use charts or other visual aids, and costumes are also fun and help students to assume character. After each 5-minute presentation, there will be two minutes for the rest of the class to ask questions. When all of the presentations have been given, the class will then vote for or against the development of Bair Island.
6. Break the class into 7 small groups of 4-5 students each. Assign each group one of the seven roles.
7. Pass out the accompanying fact sheets about each of the issues to the appropriate small groups.
8. Give the students thirty minutes to discuss, take notes, and prepare their arguments. As the students are working, walk around to each small group and ask questions to help them consider all of the pros and cons that would be of concern to people in their particular roles.
9. The next day, review the activity as well as the format for the presentations. Give the students five to ten minutes in their small groups to review their presentations.
10. Invite each small group to come up to the front of the class for their 5-minute presentation. Have a stopwatch ready so that the groups stay within the time limit. While the other students are listening to the presentations, they should be taking notes on what they hear.
11. After each presentation, allow two minutes for questions from the rest of the class.
12. Once all of the groups have presented, quickly review the stances of each of the groups and their most compelling arguments.

13. Then, have the class vote (outside of their assumed personas) on whether Bair Island should be developed or returned to wetlands based on what they heard.
14. After the vote has taken place, discuss the outcome. What persuaded the students to vote the way they did? How would that outcome affect them individually?

Assessment

Did the students have a logical, persuasive argument for or against the development of Bair Island? Did they include relevant reasoning and evidence to support their argument?

Resources

This lesson was adapted from an activity taught at the Marine Science Institute and incorporated ideas from *Save The Bay's Watershed Curriculum*.

City of Redwood City. (2005). *City Council Priorities 2004-2006*. Retrieved September 1, 2005 from

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<http://www.savesfbay.org/site/pp.asp?c=dgKLLSOwEnH&b=488827>

Save The Bay. (n.d.). Airport Debate. *San Francisco Bay Watershed Curriculum*.

Bair Island Fact Sheet - Mobil Oil Estates, Ltd.

As executives of Mobil Oil Estates, Ltd., you are interested in constructing homes, retail stores and offices that you can sell for big bucks. Your job is to buy land on which to build new developments in order to profit the company.

The "South Shores" project is important because:

- Much of the property surrounding the Bay's shoreline is already developed, in use, or protected, making Bair Island prime real estate.
- People continue to move to California and are in need of jobs and homes.
- As real estate, Bair Island could fetch \$55,000 per acre.

Other position ideas:

- Nearby Redwood Shores earns \$3 million in property and sales tax for Redwood City, almost 10% of the city's budget. South Shores could bring in even more than that.
- What is more important- open space and habitat for wildlife or homes and communities for people?
- The South Shores development would only be on inner and middle Bair Island. Outer Bair Island (about 1/3 of the total acreage) would not be built on.

Bair Island facts:

- Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish.
- At least four rare and endangered animals live on the island: the California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican.
- The island contains the South Bay's only harbor seal rookery.
- Less than 10% of the San Francisco Bay's original wetlands remain today.
- Wetlands are extremely important in controlling floods, filtering water runoff before it enters the Bay, and decreasing air pollution.

Bair Island Fact Sheet - Redwood City Council Members

As council members, you are looking out for the interests of the city and its residents. You are responsible for making decisions that affect everyone that lives, works, and does business in Redwood City. Generating income for the city is important in order to keep government-funded services, such as police, fire, libraries, schools, parks, and public works, up and running. For the years 2006-2008, your top five priorities are: community building, communication, aesthetics, creating pedestrian-friendly public places, and quality of life.

The "South Shores" project is important because:

- Much of the property surrounding the Bay's shoreline is already developed, in use, or protected, making Bair Island prime real estate.
- People continue to move to California and are in need of jobs and homes.
- As real estate, Bair Island could fetch \$55,000 per acre.
- All of the construction work needed to build South Shores would provide jobs for many people for quite a long time.

Other position ideas:

- Nearby Redwood Shores earns \$3 million in property and sales tax for Redwood City, almost 10% of the city's budget. South Shores could bring in even more than that.
- What is more important- open space and habitat for wildlife or homes and communities for people?
- The South Shores development would only be on inner and middle Bair Island. Outer Bair Island (about 1/3 of the total acreage) would not be built on.

Bair Island facts:

- Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish.
- At least four rare and endangered animals live on the island: the California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican.
- The island contains the South Bay's only harbor seal rookery.
- Less than 10% of the San Francisco Bay's original wetlands remain today.

Bair Island Fact Sheet - Redwood City Shop Owners

As owners of businesses in Redwood City, you are looking out for your own well-being. You are most interested in making a living by earning money through your business.

Position ideas:

- Nearby Redwood Shores earns \$3 million in property and sales tax for Redwood City, almost 10% of the city's budget. South Shores could bring in even more than that. This money is used for city improvements, such as fixing roads, sidewalks, and public space.
- An addition of 20,000 homes would mean more potential customers for your businesses.
- Shopping centers and corporate offices in the planned development means more competition for business from residents.

Bair Island facts:

- Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish.
- At least four rare and endangered animals live on the island: the California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican.
- The island contains the South Bay's only harbor seal rookery.
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- Wetlands are extremely important in controlling floods, filtering water runoff before it enters the Bay, and decreasing air pollution.

Bair Island Fact Sheet - Marine Science Institute

As staff of the Marine Science Institute (MSI), your job is to inspire and educate students from the Bay Area about marine life in the San Francisco Bay through hands-on activities. You hope to give people enough information that they can make informed decisions about environmental issues surrounding the bay. Bair Island is located across Redwood Creek from MSI. While teaching programs on site and from the boat, you often see many species of birds roosting on Bair Island. You also use the island as an example when teaching about wetlands.

Position ideas:

- Much of the property surrounding the Bay's shoreline is already developed, in use, or protected, which makes Bair Island prime real estate.
- People continue to move to California and are in need of jobs and homes.
- The South Shores development would only be on inner and middle Bair Island. Outer Bair Island (about 1/3 of the total acreage) would not be built on.
- For many of your programs, students collect fish and invertebrates from Redwood Creek to study. The sloughs and waterways in throughout Bair Island serve as a good safe hiding place for fish and other marine life.
- How would your programs change if the backdrop was transformed from natural open space to houses and skyscrapers?

Bair Island facts:

- Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish.
- At least four rare and endangered animals live on the island: the California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican.
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Bair Island Fact Sheet - Local Construction Union

As a construction worker and a member of the local union, you are interested in bringing as much construction work to Redwood City and surrounding areas as possible. The more developments there are to build, the more work there will be, and the more money you will make.

Position ideas:

- The construction of 20,000 homes and 4 million square-feet of office space would provide consistent work for local workers in the construction business for months and possibly years.
- Nearby Redwood Shores earns \$3 million in property and sales tax for Redwood City, almost 10% of the city's budget. South Shores could bring in even more than that.
- What is more important- open space and habitat for wildlife or homes and communities for people?

Bair Island facts:

- Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish.
- At least four rare and endangered animals live on the island: the California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican.
- The island contains the South Bay's only harbor seal rookery.
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- Wetlands are extremely important in controlling floods, filtering water runoff before it enters the Bay, and decreasing air pollution.

Bair Island Fact Sheet - Redwood City Residents

As citizens of Redwood City, you may have drastically different viewpoints. Some of you may be in the construction business, some own shops in the city, and some very concerned about preserving what little open space there is left.

Position ideas:

- Much of the property surrounding the Bay's shoreline is already developed, in use, or protected, making Bair Island prime real estate.
- People continue to move to California and are in need of jobs and homes.
- All of the construction work needed to build South Shores would provide jobs for many people for quite a long time.
- Nearby Redwood Shores earns \$3 million in property and sales tax for Redwood City, almost 10% of the city's budget. South Shores could bring in even more than that.
- What is more important- open space and habitat for wildlife or homes and communities for people?
- The South Shores development would only be on inner and middle Bair Island. Outer Bair Island (about 1/3 of the total acreage) would not be built on.

Bair Island facts:

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Bair Island Fact Sheet - Peninsula Open Space Trust

As staff of Peninsula Open Space Trust (POST), your interest is in providing permanent protection to land on the San Francisco Peninsula to retain the beauty and diversity of natural habitats for the community. You support using this land for natural resource protection, wildlife habitat, low-intensity public recreation, and agriculture. POST raises money from private donors, which is often matched by government funds, in order to purchase land for protection.

Position ideas:

- Much of the property surrounding the Bay's shoreline is already developed, in use, or protected, which makes Bair Island prime real estate.
- People continue to move to California and are in need of jobs and homes.
- The South Shores development would only be on inner and middle Bair Island. Outer Bair Island (about 1/3 of the total acreage) would not be built on.
- What would be some alternatives for Bair Island if the development didn't pass voters' approval?

Bair Island facts:

- Bair Island serves as a home for more than 125 species of birds, 13 species of mammals, and over 60 species of fish.
- At least four rare and endangered animals live on the island: the California least tern, California clapper rail, salt marsh harvest mouse, and brown pelican.
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Piecing Together a Food Web

California Content Standards

Grade 5- Science, Life Sciences 2.f.

"Students know plants use carbon dioxide and energy from sunlight to build molecules of sugar and release oxygen."

Grade 6- Science, Ecology 5.b. "Students know matter is transferred over time from one organism to others in the food web and between organisms and the physical environment."

Lesson Objective

Students will create a food web using organisms that live in the San Francisco Bay.

Materials

- Copies of the two-page Food Web Student Handout included in this lesson.
- Large sheets of paper (11"x17")
- Scissors
- Glue
- Colored pencils, crayons, or markers
- Copies of MSI's *South San Francisco Bay Invertebrate Guide* for reference. (Can be purchased at, or by calling, MSI)

Time

Preparation: Twenty minutes

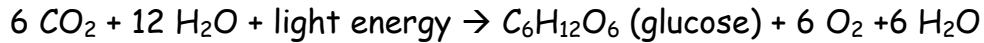
Lesson: Fifty minutes

Clean Up: Five minutes

Background

The San Francisco Bay is a nutrient-rich environment that supports a huge variety of life, from the wetlands and mudflats to beneath the water. The organisms that reside in the San Francisco Bay are all part of food chains, which create a complex food web. Each organism must either make its own energy through photosynthesis, or get it from consuming other organisms or organic matter. Complete food webs are composed of many different levels, including: producers, primary consumers, secondary consumers, tertiary consumers and decomposers.

Producers are the lowest level of the food web, and get their name from the fact that they produce energy in the form of carbohydrates. Plants are producers, as well as other organisms that photosynthesize, such as algae. Producers use energy from the sun, nutrients, water, and carbon dioxide to produce carbohydrates, oxygen and water. The chemical equation is:



Producers in the Bay include wetland plants, algae, and phytoplankton. Producers are eaten by primary consumers.

Primary consumers are the next level in the food chain, also called herbivores. This group includes zooplankton. Secondary consumers prey on primary consumers, and are carnivores. Most invertebrates, small fish, birds, and people are secondary consumers. Secondary consumers are eaten by tertiary consumers, which include fish, birds, people, seals, and sea lions. People, seals, and sea lions may also be considered quaternary consumers, preying on the tertiary consumers. It is apparent that these terms and levels are very general, and many animals fit into more than one group.

Decomposers, also called detritivores, are the organisms that feed on the nonliving organic material, and are extremely important in the process of nutrient recycling. They can be found as a link between many levels. Crabs and some worms are the decomposers of the Bay ecosystem.

Method

1. Review the term *food web*, and all of the levels as stated above.
2. Discuss some organisms that the students saw on the Discovery Voyage. What did they eat? What were their predators?
3. Tell the students that they will be creating a food web with pictures of organisms that live in the San Francisco Bay.
4. Model a food web on the chalkboard using examples from one student's breakfast, lunch or dinner. Ask questions to make sure that everyone has a good understanding about how a food web works.
5. Pass out the Food Web Student Handouts along with crayons, colored pencils, or markers, and scissors. Tell the students to color the pictures and then cut them out.
6. Pass out an 11"x17" piece of paper to each student along with some glue. The food web will be created by cutting and pasting the pictures onto the paper. The students should use markers to draw arrows between the pictures to show the direction of the food web. The arrows should be drawn in the direction that the energy (or food) is being transferred. For example, an arrow would be drawn from the sun to a plant. Remind the students that this is a food web, so that there may be more than one arrow coming from a plant or animal.
7. When the class has completed their food webs, have the students share them with the rest of the class.

8. Discuss the difference in the food webs as a group. Do they all look the same, or are some different? Why is this? Are food webs simple or complex?

Assessment

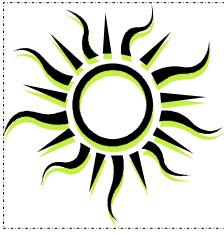
Did the students have an understanding of the food web? Were they able to create an accurate food web using the organisms from the Bay?

Resources

Campbell, N. A. (1993). *Biology*. California: Benjamin/Cummings.

Marine Science Institute. (2007). *South San Francisco Bay Invertebrate Guide*.

Food Web Student Handout - page 1



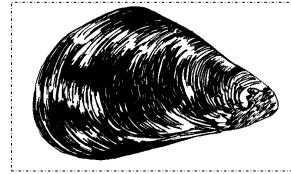
Sun



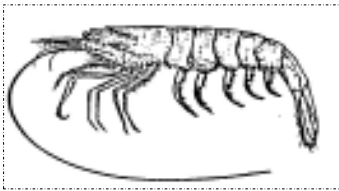
Acorn Barnacle



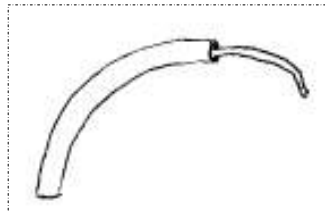
Bell Medusa



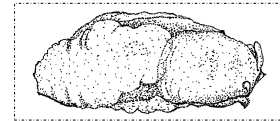
Bay Mussel



Bay Shrimp



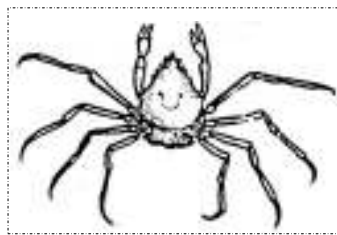
Tube Worm



Tortellini Snail



Red Beard Sponge



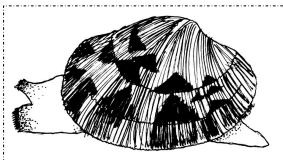
Spider Crab



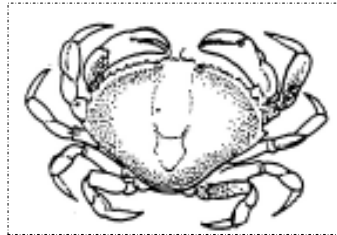
Eastern Mud Snail



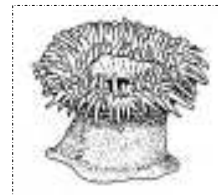
Atlantic Oyster Drill



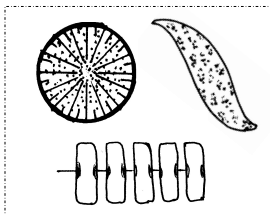
Japanese Littleneck Clam



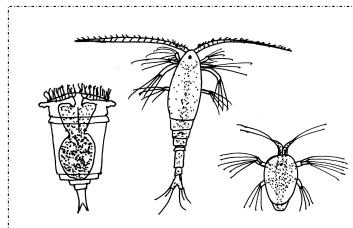
Cancer Crab



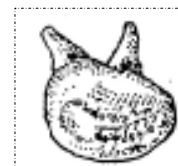
Orange Anemone



Phytoplankton

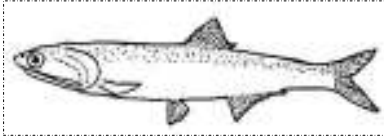


Zooplankton

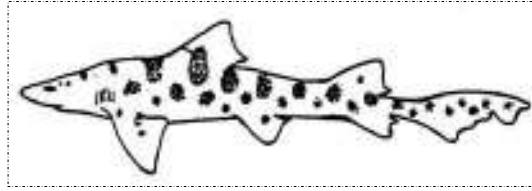


Sea Grape

Food Web Student Handout - page 2



Northern Anchovy



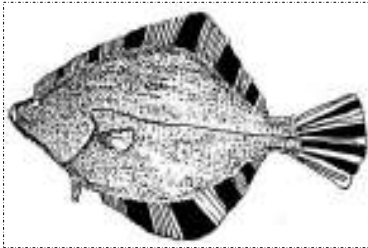
Leopard Shark



Cormorant



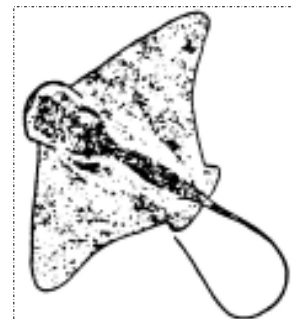
Harbor Seal



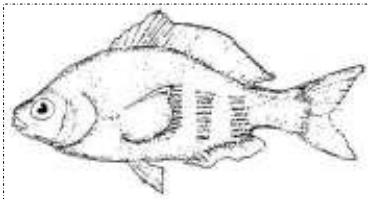
Starry Flounder



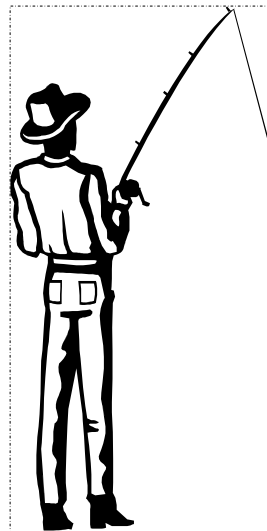
Brown Pelican



Bat Ray



Shiner Surfperch



Fisherman

The Color of Salt

California Content Standards

Grade 5- Science 3.e.

"Students know most of the Earth's water is present as salt water in the oceans, which cover most of the Earth's surface."

Grade 6- Science 5.e.

"Students know the number and types of organisms an ecosystem can support depends on the resources available and on abiotic factors..."

Lesson Objective

Students will color-code bodies of water on a world map based on their salinities.

Materials

- Copies of world map (8½"x11" to 11"x17")
*see note
- Colored pencils or crayons
- Chart showing the salinities of various bodies of water
- Chart showing the color code for the range of salinities
- Large wall-sized world map with oceans, seas, and major lakes labeled

Time

Preparation: Ten minutes

Lesson: Thirty minutes

Clean Up: Five minutes

Background

While on the Discovery Voyage, students had an opportunity to collect samples of water from the Bay and test the temperature, density and salinity. The salt water in the San Francisco Bay comes from the Pacific Ocean and enters through the Golden Gate. The primary source of fresh water for the Bay is the Sacramento and San Joaquin rivers, which drain a full 40% of the state of California. Rain and water from sewage treatment plants also adds fresh water. The water in the Estuary is layered, with the denser salt water sinking below the less dense fresh water. The difference in density between fresh and salt water affects the meeting of the two waters in a way that has implications for estuarine life. The salinity of the South Bay varies greatly over the course of a year. The winter and early spring bring low salinities (15-20 parts per thousand) with the influx of fresh water from rain and runoff, while during the summer evaporation and

the lack of significant fresh water inflow can sometimes raise the salinity to 36 parts per thousand (ppt), which is higher than the nearby ocean.

Fluctuation in salinity of any body of water has a great effect on the organisms that reside in that water. Some animals are able to adapt to variations in salinity, while others have to move around to remain in the salinity with which they are adapted in order to survive. For this reason, it is very important for marine scientists to be familiar with the physical properties of the body of water in which they are studying.

Throughout the world, different bodies of water have varying salinities. Freshwater lakes and rivers may have little to no salt, whereas places like the Dead Sea have so much salt that almost nothing can survive. Knowing the salinity (and temperature) of a body of water lets scientists hypothesize about what kinds of organisms it would be able to support.

Method

1. Review the hydrology station from the Discovery Voyage. What does parts per thousand (ppt) mean? Discuss what the salinity of the Bay water was and possible reasons for the measurement. What time of year was the voyage? Had there been a recent rain? Where was the water sample taken- from the bottom of the Bay or near the surface?
2. Ask the students whether they think the salinities of the oceans of the world and other bodies of salt water are similar, or if the salinities vary.
3. Tell the students that they will be color-coding bodies of water on a world map based on salinity.
4. Pass out copies of the world map along with the Salinity Chart to each student. You may choose to write the salinity color codes on the chalkboard, or hand them out. Make sure the colored pencils or crayons are available and the large world map is hanging where students can use it as a reference.
5. To demonstrate the activity to the class, use the San Francisco Bay as an example. (You can use the salinity that your students measured on the Discovery Voyage, or use 22ppt as an average.) On your map, color the San Francisco Bay green, according to the Salinity Chart.
6. Let the students continue their maps on their own.
7. After everyone has finished, discuss what the maps look like. Are there regions in the world where the salinities are similar? Does temperature seem to be a factor in determining salinity? Do all of the oceans have the same salinities since they flow into each other? Discuss possible reasons about why there are such differences. Also, talk about how the

organisms that live in these bodies of water may differ. Is it possible to find the same organisms in the Black Sea as in the San Francisco Bay? Why or why not?

Assessment

Did the students color their maps correctly according to salinity?

Resources

Bigelow Lab for Ocean Sciences. (2005). *Sea Surface Temperature*.

Retrieved August 31, 2005, from

http://www.bigelow.org/virtual/sst_sub1.html

Caspian Science Network. (n.d.). *Caspian Seafacts*. Retrieved February 18, 2006 from

http://www.caspinfo.net/caspian_seafacts/detail/content.htm

Finnish Institute of Marine Research. (2005, March 1). *The Baltic Sea Portal*. Retrieved August 31, 2005, from

<http://www.fimr.fi/en/itamerikanta/tietoa/yleista.html>

Office of Naval Research. (2000). *Ocean Water: Salinity*. Retrieved August 31, 2005, from <http://www.onr.navy.mil/focus/ocean/water/salinity1.htm>

Russian Academy of Sciences. (n.d.). *White Sea Biological Station*. Retrieved February 18, 2006, from <http://www.zin.ru/wsbs/>

United States Geological Survey. (n.d.). Why is the Ocean Salty? Retrieved February 18, 2006 from the Palomar College Web site:

http://www.palomar.edu/oceanography/salty_ocean.htm

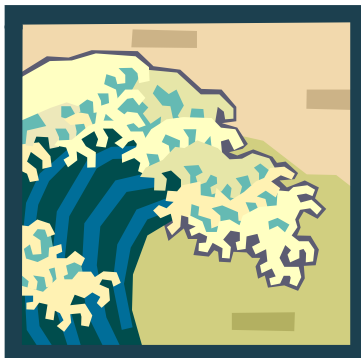
*Note- The map included in this lesson was downloaded from

<http://commons.wikimedia.org/wiki/Image:BlankMap-World-alt.png>

and is available for public use. It can be downloaded and printed onto larger paper if desired.

Average Salinities of Various Bodies of Water Around the World

<u>Water</u>	<u>Salinity (ppt)</u>
The Great Lakes	<1
Baltic Sea	6-20
Caspian Sea	12
Black Sea	16
San Francisco Bay	22
Puget Sound	24
White Sea	25
Hudson Bay	28-31
Arctic Ocean	33
Pacific Ocean	35
Indian Ocean	35
Caribbean Sea	35
Atlantic Ocean	36
Mediterranean Sea	39
Red Sea	41.5
Dead Sea	300



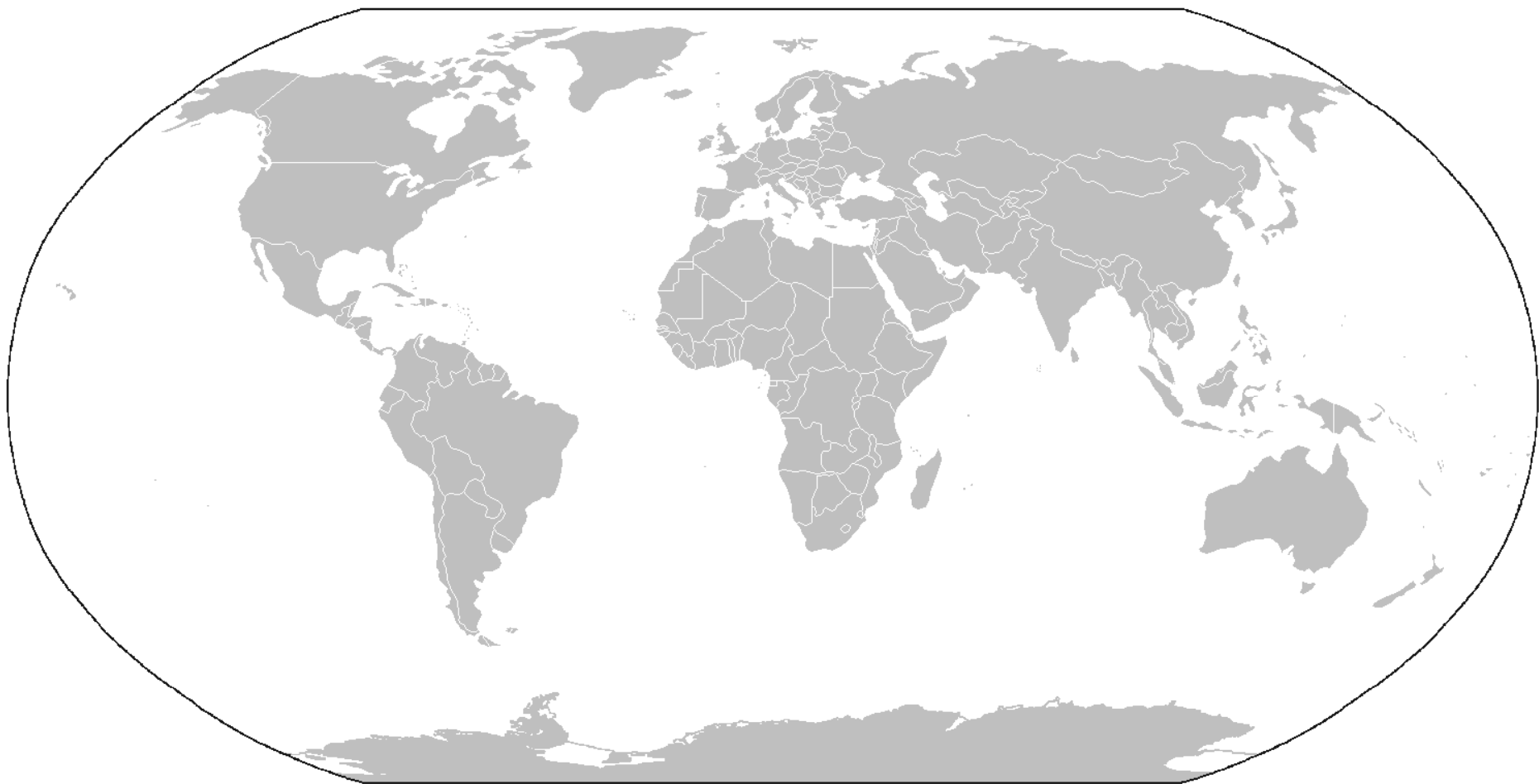
Salinity Color Codes

<u>Salinity (ppt)</u>	<u>Color</u>
<1	yellow
1-25	green
26-39	blue
>40	purple

Note:

- Fresh water <1ppt
- Brackish water 1-25ppt
- Salt water 25-39 ppt
- Hypersaline water >40ppt

The Color of Salt



A Long Journey

California Content Standards

Grade 5- Science, Earth Sciences 3.d. "Students know the origin of the water used by their local communities."

Grade 6- Science, Resources 6.b. "Students know different natural energy and material resources, including...fresh water...and know how to classify them as renewable or nonrenewable."

Lesson Objective

Students will trace the path the water we use takes from its source until it goes to the water treatment plant.

Materials

- Copies of a map of your watershed (you should be able to get a map from your local water district)
- Markers

Time

Preparation: Twenty minutes

Pre-lesson Field Trip: One to two hours plus transportation time

Lesson: Thirty minutes

Clean Up: Two minutes

Background

The water that we use in the San Francisco Bay Area comes from a variety of sources. Depending on where you live, you may receive water from the Hetch Hetchy watershed in Yosemite, the Alameda watershed, the Peninsula watershed, the Sacramento-San Joaquin River Delta, underground, or all of these sources! The water may come straight out of a river, be stored for a while in a reservoir, or flow out of the ground.

The water cycle is a continuous cycle in which water:

- evaporates- becomes vapor and goes into the air;
- condenses- changes back into liquid and forms clouds;
- precipitates- falls back to the earth as rain, hail, or snow and goes into lakes, rivers, or oceans, or soaks into the ground.

In order for us to have water for continued use, it must be replenished. Generally, water is renewable; the water cycle keeps our lakes full and rivers running. However, human use makes some water resources nonrenewable. It sometimes takes hundreds of years for groundwater aquifers to collect water. In many places in California, groundwater is used faster than it is replaced, causing the land to sink. In years of drought, this is especially

true. Pollution of the water due to runoff, pesticide and fertilizer use also means that there is less fresh water that is usable by people. Another limit to our water resources is population growth. More people in an area means that more water is being used. This water must be replaced in order for the cycle to continue.

Pre-lesson Field Trip

Plan and take a field trip to your local water treatment plant to learn where your students' drinking water originates, and how it is cleaned before being sent to their homes. Most water districts offer free tours of water treatment plants to school groups that last between 1-2 hours, and also provide educational materials to teachers. Following is contact information for some Bay Area water districts.

Contra Costa Water District- Marianne Hook (925) 688-8307

<http://www.ccwater.com/education/>

East Bay Municipal Utility District- (510) 287-0138

http://www.ebmud.com/services/education_&_outreach/

Marin Municipal Water District- (415) 945-1455

<http://www.marinwater.org>

San Francisco Public Utilities Commission- Samuel Murray (415) 554-3275

<http://sfwater.org>

Santa Clara Valley Water District- Kathy Machado (408) 265-2607 x2331

http://www.valleywater.org/For_teachers_and_students/School_program/index.shtm

Method

1. Review what the students learned about their drinking water on the field trip. Discuss where the water comes from, where it goes, and what happens to it before it is sent to their homes.
2. Explain to the students that they will be tracing the path a drop of water takes from where it begins its journey in the watershed until it winds up at their home.
3. Pass out markers and maps of the watershed to the students. You may be able to get the maps from the water district.
4. Tell the students that they can choose the source of their drop of water. It may be a river, creek, underground aquifer, lake, fall as rain into a reservoir, or "originate" somewhere else!
5. Starting at the drop's source, have the students mark the path the water takes to the treatment plant, and then to their homes.

6. Discuss why this path is so important. What would happen if we had a drought for a few years? What would happen if a million more people moved to the Bay Area? What would happen if there was an earthquake? Would this affect the availability of clean water? How can we make sure that there is always enough water available for the residents of our communities?
7. Address the issue of water conservation. Have the students brainstorm ideas about how they can conserve water, and create a list to hang in your classroom.

Assessment

Were the students able to correctly draw the path water takes from its source to the place where it is treated?

Resources

- Santa Clara Valley Water District. (2002). *Where your water comes from*. Retrieved September 1, 2005, from http://www.valleywater.org/Water/Where_Your_Water_Comes_From/index.shtml
- U.S. Environmental Protection Agency. (2005, March 15). *The Water Cycle*. Retrieved September 1, 2005, from http://www.epa.gov/safewater/kids/flash/flash_watercycle.html
- U.S. Environmental Protection Agency. (2005, March 15). *Water Treatment Process*. Retrieved September 1, 2005, from <http://www.epa.gov/safewater/kids/watertreatmentplant/index.html>

Drifting Delicacies

California Content Standards

Grade 5- Science 2.f.

"Students know plants use carbon dioxide and energy from sunlight to build molecules of sugar and release oxygen."

Grade 6- Science 5.a.

"Students know energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food webs."

Lesson Objective

Students will create a model of plankton adapted to live at the surface of the water either to capture sunlight or to consume other plankton.

Materials

- Clay- a golf ball-size piece per two students
- A large (at least 5 gallon, the taller the better), **clear** bucket filled with water
- A stopwatch
- Chalkboard and chalk

Time

Preparation: Fifteen minutes

Lesson: Forty-five to sixty minutes

Clean Up: Ten minutes

Background

Plankton are organisms that drift through the water. They can be found in any watery habitat, from the vast oceans to tiny streams and ponds. Plankton are either plant-like or animal. Most plankton are microscopic, but some reach 50 feet or more (e.g. jellies). On the Discovery Voyage the students used a plankton net to capture these tiny organisms and were able to observe them under a microscope. Plankton generally are found at the surface of the water. Phytoplankton (plant-like drifters) need to be at the surface of the water in order to use the sunlight for photosynthesis. Zooplankton (animals) also live at the surface of the water. They are consumers and subsist on phytoplankton or other zooplankton. There are a few ways that plankton are able to remain at the surface of the water. Phytoplankton have a small vacuole of oil inside of the cell. The oil allows them to float on the water. Zooplankton usually rely on their many appendages, which increase their surface area, causing drag. This slows their settling rate. They also are motile, and are able to move up and down within the water column.

Method

1. Review what was learned about plankton on the Discovery Voyage. Remind students that plankton are a very important part of the food chain. Phytoplankton are the main producers in the Bay.
2. Review photosynthesis. Phytoplankton need sunlight, water, carbon dioxide and nutrients for photosynthesis. They produce sugar (glucose), oxygen, and water. Remind students that the need for sunlight is why plankton are found at the surface of the water.
3. Discuss how zooplankton cannot make their own energy because they are animals. They are consumers. They must get their energy from eating phytoplankton, the producers. Zooplankton are found at the surface because that's where the phytoplankton are found.
4. Tell students that they are going to be designing a new type of plankton. It may be either a plant or an animal, but it should be able to stay at the surface of the water as long as possible where it can either capture the sunlight or food!
5. Place the students in pairs. Pass out a ball of clay to each pair. Give the students 15 minutes to construct their plankton. They must use all of the clay, but the plankton can be whatever shape they choose!
6. After 15 minutes, have the students test out their design! Get the stopwatch ready! One at a time, have each pair come up to the bucket and place their plankton on top of the water. Time how long it takes from the moment the plankton is released until it hits the bottom. Record times on the chalkboard.
7. After each pair has had a turn, discuss which models took the longest to reach the bottom of the bucket. What do they have in common? Discuss ways in which plankton keep afloat.
8. Let the students create new models and try again. Do their times improve?

Assessment

Did the students understand the concepts of surface area and/or creating a vacuole to help keep the plankton afloat? Did they improve their designs on the second try?

Resources

This lesson was adapted from an activity taught at Catalina Island Marine Institute, CA.

Diatom to a Dime

California Content Standards

Grade 5- Mathematics,
Number Sense 1.1.

"Estimate, round, and manipulate very large and very small numbers."

Grade 6- Mathematics,
Number Sense 1.3.

"Use proportions to solve problems. Use cross-multiplication as a method for solving such problems..."

Lesson Objective

Students will compute the relative sizes of a diatom and a dime.

Materials

- Paper
- Pencils
- Dimes
- Rulers (cm)
- Tape measure (cm)

Time

Preparation: Two minutes

Lesson: Thirty minutes

Clean Up: Two minutes

Background

Diatoms are a type of phytoplankton, tiny plant-like organisms that drift in the water. It is likely that the students observed diatoms during the plankton station of the Discovery Voyage. Diatoms are single-celled or colonial organisms that photosynthesize. They are the basis of the food chain in the San Francisco Bay as well as in other bodies of water all over the world. Their importance, however, is inversely proportional to their size. They are microscopic and thousands of them may be found in just one teaspoon of water. Along with other phytoplankton, they produce up to 80% of the world's oxygen!

Method

1. Review what the students learned about diatoms on the Discovery Voyage.
2. Explain to the students that they will be comparing the size of a centric diatom to the size of a dime. Ask them if a diatom were enlarged to the size of a dime, how big, proportionally, would that dime then be?

3. Let the students make some guesses as to how big a dime would be if it were magnified the same amount as the diatom. Would it be as big as a quarter? A tennis ball? Basketball? Would it fit in the classroom?
4. Tell the students that the diameter of a centric diatom is between 10 and 150 microns. A micron is one thousandth of a millimeter! That means there are 1,000 microns in a millimeter, or 10,000 microns in one centimeter! For ease, use 100 microns as the measurement of the diatom for comparison. As a class you may convert 100 microns to centimeters.

$$100 \text{ microns} = x \text{ cm}$$

$$100 \text{ microns} (1\text{cm}/10,000\text{microns}) = .01 \text{ cm}$$

5. Now, pass out the dimes and rulers and have the students each measure the diameter of a dime in centimeters. (The diameter is approximately 2cm).
6. So, if a diatom were enlarged to the size of a dime, how big would the dime be? Create a ratio in order to figure out the problem:

$$.01\text{cm}/2\text{cm}=2\text{cm}/x$$

$$.01\text{cm}(x)=4\text{cm}^2$$

$$x=4\text{cm}^2/.01\text{cm}$$

$$x=400\text{cm}$$

The dime would have a diameter of 400cm!

7. Take the tape measure and measure out 400cm (4meters). Discuss with the class their earlier guesses about how big the dime would be. Were they close to the answer? Why or why not? Did they think that the proportionate size of the dime would be smaller or larger? Why is it difficult for us to perceive the size of small objects?

Assessment

Did the students have an understanding of the question? Were they able to write an equation for the problem? Were they able to solve the problem?

Resources

Smith, D. L., & Johnson, K. B. (1977). *A Guide to Marine Coastal Plankton and Marine Invertebrate Larvae*. Iowa: Kendall/Hunt.

Who Needs Mittens?

California Content Standards

Grade 5- Language Arts, Writing 1.1. "Students create multiple-paragraph narrative compositions."

Grade 6- Language Arts, Writing 1.1. "Students choose the form of writing that best suits the intended purpose."

Lesson Objective

Students will compose a narrative (or other form of writing) explaining why Chinese mitten crabs have mittens.

Materials

- Paper
- Pencils

Time

Preparation: Two minutes

Lesson: Forty-five minutes

Clean Up: Two minutes

Background

You may have observed a Chinese mitten crab on your Discovery Voyage. They are named for the dense patches of hair found on their claws, which resemble mittens. Chinese mitten crabs are native to the rivers and estuaries of the Yellow Sea. The crab was unintentionally introduced to Germany in the early 1900s, most likely via ballast water of ships, and quickly spread to other parts of Europe. It was first collected in the San Francisco Bay by shrimp trawlers in 1992, and has since spread throughout the Estuary. Introduction to the San Francisco Estuary was probably due to ballast water, but it is possible that the mitten crab was deliberately released in order to establish a fishery. In Asia, the Chinese mitten crab is considered a delicacy.

Chinese mitten crabs are catadromous, which means that they grow and develop in freshwater and migrate to saltwater to reproduce. During most of the year, they burrow in banks and levees in the rivers and streams. In the San Francisco Bay, the mitten crab matures in 2 to 3 years and females can carry 250,000 to 1 million eggs. The crabs grow to a width of 3 inches (measured across their carapace, or shell). Chinese mitten crabs are omnivores. When young, they eat mostly vegetation, but prey on invertebrates as they grow. Not much is known about what preys on them in the Estuary, but there have been reports of white sturgeon, striped bass, bullfrogs, loons and egrets eating mitten crabs.

Mitten crabs have a great impact on the ecology of the San Francisco Bay. They accelerate the erosion of banks and levees by creating burrows. They are also an intermediate host for the Oriental lung fluke, which is a human parasite. In addition, they compete with other animals for food and prey on native invertebrates. Chinese mitten crabs have great potential to further damage our already fragile ecosystem. For this reason, and because of their invasive nature, it is illegal to keep or transport a live mitten crab.

Method

1. Read to the class the above information, or review what you learned about the Chinese mitten crab on the voyage.
2. Tell the students that they are going to write a creative story about how the Chinese mitten crab got its mittens and why they have them.
3. For 5th grade, review the criteria for a narrative: narrative compositions establish and develop a situation or plot, describe the setting, and present an ending. Sixth grade students may choose to write a narrative, poem, letter or other form of creative writing.
4. When the students are finished with their stories, have some volunteers share their ideas!

Assessment

Did the students:

- Come up with a creative reason as to how the Chinese mitten crab got its mittens?
- Furnish an explanation for why they have mittens?
- Follow the criteria for a narrative? Or,
- Choose an appropriate form of writing for the purpose of their story?

Resources

Department of Fish and Game, Bay-Delta. (1998). *Life History and Background Information on the Chinese Mitten Crab*. Retrieved June 14, 2003, from <http://www.delta.dfg.ca.gov/mittencrab/>

Invent an Invertebrate

California Content Standards

Grade 5- Science 6.a.
"Students will classify objects in accordance with appropriate criteria."
Grade 6- Science 5.c.
"Students know populations of organisms can be categorized by the functions they serve in an ecosystem."

Lesson Objective

Students will create invertebrates designed to live in a specific habitat within the San Francisco Bay and then classify the invertebrates based on similar characteristics.

Materials

- Paper, pencils, crayons, and/or markers, **OR**
- Clay, pipe cleaners, beads, straws, etc.

Time

Preparation: Five minutes to gather materials
Lesson: Forty-five to sixty minutes
Clean Up: Five minutes

Background

On the Discovery Voyage, the students learned about many invertebrates (animals without a backbone) that inhabit the San Francisco Bay. Each is specialized to live in a specific habitat by its feeding strategies, defense mechanisms, camouflage, maneuverability, and predator/prey interactions. Invertebrates can be found in many places within the Bay such as: in the mud, on the mud, attached to another animal, attached to rocks or piers, on algae or other plants, or drifting through the water. Some examples of San Francisco Bay invertebrates are: sponges, mussels, crabs, clams, slugs, snails, jellies, worms, shrimp, barnacles and sea squirts. For more information, please refer to the *South San Francisco Bay Invertebrate Guide* available from the Marine Science Institute.

All living organisms are classified, or organized into groups, based on their similarities and genetic makeup in order to make them easier to understand. In biology, organisms are classified using a system designed by Linnaeus. However, organisms can truly be classified many different ways, based on where they live, what they eat, how they eat, how they move, etc.

Method

1. Review with the class the invertebrates that were studied on the Discovery Voyage. Choose a couple of organisms and discuss what enables these animals to live where they do based on prey, predators, how/if they move, and defense strategies.
2. Place students in groups of four. Assign each group a habitat within the Bay: beneath the mud, on the mud, attached to another animal, attached to a rock or pier, on algae or another plant, or drifting through the water.
3. Tell the students that each group will be inventing an invertebrate to live in their assigned habitat. They must work together, but each of them will be responsible for a specific adaptation. As a group they must also name their animal.
4. Assign each student in the group an adaptation:
Feeding- How and what does it eat?
Defense- Who are its predators and how does it defend itself? Does it camouflage, taste bad, have a shell, pincers, or sting?
Size- How big or little is it? Why is this an advantage?
Movement- Does it move around or is it sessile (stays in one place)?
5. Give the students 30 minutes to create their invertebrate. They may use paper and markers to draw or, if chosen, clay, beads, straws, pipe cleaners, etc. to create a model. Tell the students that each group will be presenting their animal to the class.
6. Have each of the groups present their invertebrate to the class, making sure to include all of its adaptations.
7. After the presentations, discuss which invented invertebrate the class thinks would have the best chance of surviving in the San Francisco Bay. Which one would be most likely to fill a niche, or create a new one? Why?
8. Next, see if the students can classify their animals in a way other than where they live. Are there a couple of invertebrates that eat the same thing or have a similar means of defense?

Assessment

Did the students invent an invertebrate appropriate for the environment?
Were all of the required adaptation criteria included?

Options

This activity can also be done with fish, plankton, or another group of organisms.

Making Sense of it All

California Content Standards

Grade 5- Mathematics, Statistics 1.2. "Students organize and display single-variable data in appropriate graphs..."

Grade 6- Mathematics, Statistics 2.1. "Students compare different samples of a population with the data from the entire population and identify a situation in which it makes sense to use a sample."

Lesson Objective

Students will graph the results from fish data taken during their Discovery Voyage.

Materials

- Paper (plain and graph)
- Pencils
- Compasses (for drawing circles and angles)
- Copies of fish data sheets (get from MSI instructor after voyage, or call MSI at 650-364-2760 for a copy)

Time

Preparation: Two minutes

Lesson: Thirty minutes

Clean Up: Five minutes

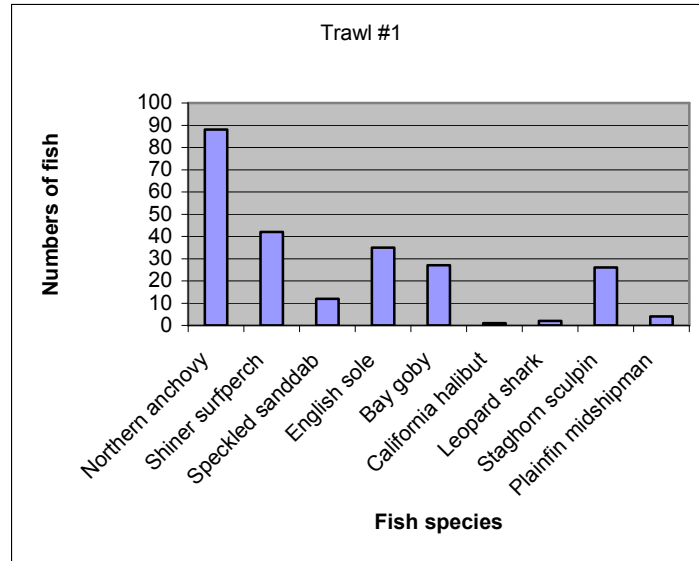
Background

Many varieties of fish call the San Francisco Bay their home. However, human activities have made it increasingly difficult for fish to live in the Estuary. At one time, the Bay was the site of thriving commercial fisheries for salmon, striped bass, herring, sturgeon, shrimp, and Dungeness crabs. Today, the Bay only supports commercial bait shrimp and herring fisheries. Environmental monitoring studies have indicated that striped bass numbers are 20% of what they were in 1960 and Chinook salmon are down to 30% of their original number. Without environmental monitoring studies, no data would have been available to calculate these losses. In 1992, MSI's Monitoring Program was created to collect long-term data on fish abundance in South San Francisco Bay. On most voyages, data is recorded on all fish collected in the trawls. Interns identify all of the fish count them, and record their size before returning them to the water. The data is put into a database where it accessible to the public via the Internet.

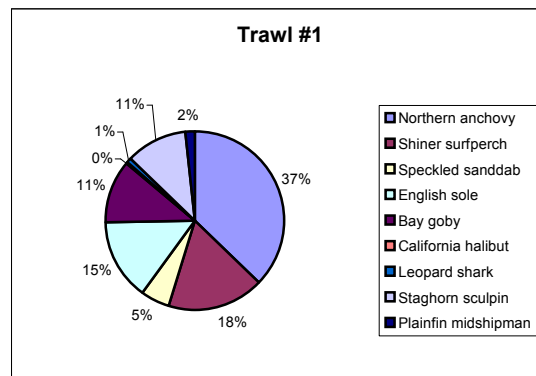
Method

1. Review with the class the different ways to graph data (pie chart, histograms, etc.)

- Hand out copies of the data sheets to students and explain how they are organized. The species names are on the left, and the "N" column tells the number of fish per species caught. The numbers in the right hand column are the lengths of the individual fish.
- Let the students graph the data from their trawl. They may choose to create a bar graph, a pie chart, or another representation. To begin, everyone should graph the number of each species caught. For 6th grade, have several of the students join all of the data sets together to graph.



Example of a bar graph for trawl data



Example of a pie chart for trawl data

- After students' graphs are completed, discuss possible reasons for the results. Why were there more of one species of fish than another? Were the trawls similar, or did they differ greatly? Does the season or weather have any affect on which fish are caught?

5. For 6th grade, discuss whether the samples (each trawl) represented the whole data set (all of the trawl data put together). If so, was this to be expected? If not, why was the data from the trawls different? If the class were going to do a study on the fish in the San Francisco Bay, how many samples (trawls) would they want to take? Why?

Assessment

Did the students graph the numbers of fish correctly? Could they correctly identify patterns in the data from the graphic representation?

Options

Create graphs based on numbers of top, middle and bottom dwelling fish, or the size of a certain species of fish caught.

Glossary

adaptation - A trait of an organism, resulting from natural selection, that makes the organism better suited to survive in its environment.

algae - Simple, photosynthetic organisms of which the largest group is seaweeds.

ballast water - Water carried in ships and used for stabilization. Ballast water taken from a marine or aquatic environment contains millions of microorganisms.

brown pelican - The smallest species of pelican; its populations were once threatened by pesticides such as DDT.

California clapper rail - An endangered species of bird, characterized by its hen-like appearance and long orange bill, that now lives solely in marshes in the San Francisco Bay.

California least tern - A species of bird that nests, roosts and feeds in the San Francisco Bay; listed as endangered.

carapace - The part of a crustacean's exoskeleton that covers the dorsal surface of its body, not including the tail.

carnivore - An animal that mainly eats meat.

catadromous - Organisms that live in fresh water, but migrate to salt water to spawn.

consumer - An organism that cannot synthesize its own food and must eat to obtain energy.

decomposer - An organism that obtains energy from non-living organic material, breaking it down in the process.

density - The ratio of something's mass to its volume.

detritivore - An organism that consumes dead fragments of other organism to obtain energy.

diatom - A single-celled alga; one of the most common types of phytoplankton.

ecosystem - A community of organisms interacting with its non-living environment.

endangered - A population of organisms at risk of becoming extinct.

estuary - A partially-enclosed body of water where fresh and salt water meet and mix.

hydrology - The study of water.

invertebrate - An animal without a backbone.

micrometer (micron) - One-thousandth of a millimeter.

mudflat - Layers of bay mud exposed when the tide is low.

nonrenewable resources - Natural resources that are limited in supply and are depleted by use faster than they can be regenerated.

omnivore- An animal that eats plants and meat.

organic - Derived from a living organism,

photosynthesis - The process by which living organisms, such as plants and algae, capture light energy and convert it into chemical energy.

phytoplankton - Microscopic, photosynthetic organisms that form the basis of most marine and aquatic food webs.

producer - An organism that makes its own food from inorganic substances.

renewable resources - Resources that are replenished by natural processes and can be used forever if they are not overused in the short term.

rookery - A colony of breeding animals.

salinity - The amount of salt in water, usually measured in parts per thousand.

salt marsh - A wetland regularly flooded and emptied by the tides that occurs along the shore of estuaries has fluctuating salinity and is dominated by grasses.

salt marsh harvest mouse - A small rodent endemic to the tidal marshes of the San Francisco Bay; listed as an endangered species.

slough - A tidal waterway.

trawler - A fishing vessel that uses nets called "trawls."

wetland - Land that is saturated with water.

Marine Science Institute

Post-Discovery Voyage Educator Guide

Lesson Evaluation

Please assist us in improving and refining the lessons included in this guide by completing the following evaluation. Thank you!

Grade _____ School _____ Date _____

Name (optional) _____ Email (optional) _____

Rate each lesson that you used in your classroom according to the following items using a scale of 1-5, where:

1= Strongly Agree; 2= Agree; 3= Neutral; 4=Disagree; 5= Strongly Disagree

	Translating the Tides	Whose Home on Bair Island?	Piecing Together a Food Web	The Color of Salt	A Long Journey
The lesson was easy to use.					
The time allotted was correct.					
The directions were easy to understand.					
Materials needed were easily accessible.					
The lesson was grade-appropriate.					
The lesson was aligned well with content standards.					
I was given adequate background information to complete the lesson.					
My students enjoyed the lesson.					

	Drifting Delicacies	Diatom to a Dime	Who Needs Mittens?	Invent an Invertebrate	Making Sense of it All
The lesson was easy to use.					
The time allotted was correct.					
The directions were easy to understand.					
Materials needed were easily accessible.					
The lesson was grade-appropriate.					
The lesson was aligned well with content standards.					
I was given adequate background information to complete the lesson.					
My students enjoyed the lesson.					

Which lessons did you choose not to use? Why?

Which lessons worked well?

Which lessons did not work as well? Why?

How could one or more of these lessons be improved?

Additional comments: