Jean-Michel Cousteau OCEAN ADVENTURES

PBS

National Marine Sanctuaries

Every Square Inch Counts: Monitoring Abundance in the Rocky Intertidal Zone and Subtidal Zone with Life-Sized Photos

Using life-sized photographs, students participate in environmental monitoring of rocky intertidal and subtidal organisms.

SUBJECTS
Science

GRADE LEVEL
7 - 12

TIME
45 minutes

OBJECTIVES
Students will be able to

- visually identify the following rocky intertidal organisms: giant green anemones, chitons, whelks, turban snails, green pin-cushion alga, sea lettuce, rockweeds, coralline algae, red algal turf, turkish towel, iridescent algae, aggregating anemones, limpets, mussels and acorn barnacles.
- visually identify the following subtidal organisms: hydrocoral, orange cup coral, sponge, strawberry anemones, crinoids and seastars.
- learn to monitor the relative abundance of rocky intertidal organisms using the same sampling techniques used by the Long-term Monitoring Program and Experiential Training for Students (LiMPETS), practicing with life-sized photo quadrats.
- complete data sheets recording the abundance of organisms in rocky intertidal and subtidal zones and compare abundance and organisms.

BACKGROUND

The five West Coast National Marine Sanctuaries (Olympic Coast, Cordell Bank, Gulf of the Farallones, Monterey Bay and Channel Islands) are working together to use field-based workshops and emerging technologies to engage middle and high school students in environmental monitoring efforts. The Long-term Monitoring Program and Experiential Training for Students (LiMPETS) program was developed to standardize environmental monitoring protocols for sandy beach and rocky intertidal zones in the West Coast National Marine Sanctuaries. Students involved in the monitoring projects are able to compare and contrast their information with data collected at other sites. This activity allows students to practice the sampling techniques in the classroom before going into the field.

Measuring the relative abundance is a way to determine the health of an area. Large numbers of people frequently visit rocky intertidal areas, which can adversely affect the health of the environment. The baseline data collected by the LiMPETS network is part of an online database that allows the sanctuary to track changes in the environment over time.

Intertidal monitoring in the field is done along a transect line that runs from the low tide zone to the high tide zone. Students collect data along this line and observe differences between the different tidal zones. Every five meters, the students place a 0.25 m^2 quadrat and monitor the organisms in the area. The students use the same sampling techniques in the field as the ones described in this activity. For larger invertebrates, they count individuals found within the quadrat. In addition, they count the relative abundance of algae and invertebrates that are more common. This activity helps students become familiar with the sampling techniques used by scientists and makes them more comfortable with identifying the organisms in the field. Having classroom practice before a field experience also helps to ensure that the data will be more accurate.

MATERIALS

- Intertidal and Subtidal Photo Quadrats printed on 8.5 x 14 inch paper (see Preparation)
- Photo Quadrat Data Sheets Student Handout
- Photo Quadrat Answer Sheet Teacher Handout
- Animal and Algae ID Cards Student Handout (see Preparation)
- Copy of *America's Underwater Treasures* episode of ***Jean-Michel Cousteau: Ocean Adventures*** (optional)
- *America's Underwater Treasures* Viewing Guide, found at pbs.org/oceanadventures/educators/ treasures (optional)

WEB LINKS

Intertidal and Subtidal Photo Quadrats and ID Cards
http://www.cordellbank.nos.noaa.gov/education/teacherresources.html

STANDARDS

National Science Standards
http://www.nap.edu/catalog/4962.html

Unifying Concepts and Processes:
Systems, order and organization
Constancy, change and measurement

Grades 5-8
Science As Inquiry – Content Standard A:
Abilities necessary to do scientific inquiry

Life Science – Content Standard C:
Structure and function in living systems
Populations and ecosystems
Diversity and adaptations of organisms

The subtidal environment of Cordell Bank in California is too deep to study by scuba or use quadrats to estimate relative abundance. The sanctuary uses video cameras and an observer in a deep-sea submersible to learn about the invertebrate cover on this deep, rocky reef. This activity is intended to provide a comparison between the subtidal environment of Cordell Bank and the intertidal habitats in the Gulf of the Farallones through photos. Students can assess the abundance of the site and compare the depths (zones) from which the photos were taken.

TEACHER PREPARATION

Print intertidal and subtidal photo quadrats:
On the Web site identified under Web Links, there are six intertidal photos and four subtidal photos to be printed on 8.5 x 14 inch paper. To print the photo quadrats, drag the image to the Desktop and open the file. Under "Page Setup," select "Legal" paper size and "Landscape," then print. The subtidal images were taken at Duxbury Reef in Bolinas, California. The subtidal photos were taken through the porthole of a submersible on Cordell Bank in California.
Print subtidal and intertidal ID cards

PROCEDURE

1. **Introduce monitoring:** Begin the discussion by showing students pictures of rocky intertidal and subtidal zones and defining the characteristics of these environments. Ask students why monitoring the abundance of organisms in these zones is important and how this sort of information can be used. Explain to students that they will learn the exact procedure that biological oceanographers use to monitor the population of target species in the intertidal zone.

2. **Explain procedures:** Students should work in small groups and monitor at least two photo quadrats. Each group should have one or two ID Cards from both subtidal and rocky intertidal zones.

3. **Explain how to draw quadrats:** On each photo quadrat, students will draw six equal-sized boxes. Each photo quadrat is 8.5 x 14 inch, and each box should measure 4 x 4.5 inch. The photo quadrat has a ¼-inch border.

4. **Instruct students on using two methods to monitor abundance:** For each photo, students will monitor the abundance of algae and animals in each quadrat using two methods. For the larger invertebrates, students record a total count of the number of individuals under "individuals" on the data sheet. For algae and the more abundant animals, students should record the number of squares out of six showing any portion of the algae or animal under "count and record" on the data sheet. The organism is counted if it is attached in

Grades 9-12
Science as Inquiry -
Content Standard A:
Abilities necessary to do scientific inquiry

Life Science -
Content Standard C:
Biological evolution
Interdependence of organisms
Matter, energy and organization in living systems

Ocean Literacy:
Essential Principles and Fundamental Concepts
http://coexploration.org/oceanliteracy/

Essential Principle #5:
The ocean supports a great diversity of life and ecosystems.
a. Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.
d. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.
e. The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.
f. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially; that is, it is "patchy."

that square. This is a very challenging method to use with photographs, yet it provides a relative abundance measurement and good practice for doing the real thing outside.

5. **Explain how to complete data sheets:** Students should fill out the photo quadrat data sheet by looking to see if each species listed on the data sheet is present in the quadrat.

6. **Debrief:** Discuss with class which organisms were hard to identify and how this would be different in the field. Ask students to explain some of the limitations in measuring abundance of species using this technique. Ask students to explain the benefits of measuring abundance using this technique. Ask students how they might design a technique to measure abundance that would retain the advantages that they have identified but would solve some of the limitations that they have identified. How can scientists measure abundance in the subtidal from a submersible? Ask students what sort of decisions resource managers might make based on data collected by this method. Ask students to compare the rocky intertidal organisms to the subtidal organisms. What types of feeding strategies does each have? Why are some organisms more abundant at one depth than another?

EXTENSIONS

- Have students write short essays on how the abundance of marine invertebrates directly affects their own lives or how they themselves directly affect marine invertebrates when visiting tidepools.
- View the segment on Cordell Bank from the *America's Underwater Treasures* episode of ***Jean-Michel Cousteau: Ocean Adventures***.

FURTHER RESOURCES

Additional educator resources for ***Jean-Michel Cousteau: Ocean Adventures*** can be found at **pbs.org/oceanadventures**.

Also try:

- **The Bridge**
  www.vims.edu/bridge/
  Click on "Ocean Science Topics" in the navigation menu to the left, then "Habitats," then "Coastal," then "Rocky Shores."

- **LiMPETS** (Long-term Monitoring Program and Experiential Training for Students)
  http://limpets.noaa.gov

Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

Essential Principle #7:
The ocean is largely unexplored.

a. The ocean is the last and largest unexplored place on Earth -- less than 5 percent of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.
d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.

CREDIT

Used with permission from Cordell Bank National Marine Sanctuary.

This activity was adapted from the LiMPETS Rocky Intertidal classroom kit developed by Dr. John Pearse, UC Santa Cruz, and Dawn Osborn, UC Santa Cruz. Subtidal comparison was added and adapted by Cordell Bank National Marine Sanctuary.

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Every Square Inch Counts
Student Handout

1A

Rocky Reef/Subtidal Data Sheet

PLACE CENTER OF QUADRAT OVER THE PHOTO QUADRAT

		PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID
		A	B	C	D
DEPTH					
NOTES	**INDIVIDUALS – COUNT IF ANY PORTION OF THE ANIMAL IS IN THE 1/4 M2 QUADRAT.**				
	ORANGE CUP CORAL				
	UPRIGHT HYDROCORAL				
	SEASTAR				
	CRINOIDS				
	UNIDENTIFIED SPECIES				
	COUNT AND RECORD THE NUMBER OF SQUARES OUT OF SIX WITH ANY ATTACHED PIECE OF:				
	STRAWBERRY ANEMONES				
	SPONGE				
	BARE ROCK				

Rocky Intertidal Data Sheet

	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID
	1	2	3	4	5	6
INDIVIDUALS - COUNT IF ANY PORTION OF THE ANIMAL IS IN THE PHOTO QUADRAT.						
GIANT GREEN ANEMONE - *ANTHOPLEURA XANTHOGRAMMICA*						
CHITONS - *MOPALIA SPP./NUTTALLINA CALIFORNICA/ LEPITOCHITONA SPP.*						
WHELKS - *ACANTHINUCELLA SPP./NUCELLA SPP.*						
TURBAN SNAILS -*TEGULA BRUNNEA/FUNEBRALIS*						
COUNT AND RECORD THE # OF SQUARES OUT OF SIX WITH ANY ATTACHED PIECE OF:						
GREEN PIN-CUSHION ALGA - *CLADOPHORA COLUMBIANA*						
SEA LETTUCES - *ENTEROMORPHA/ULVA SPP.*						
FLATTENED ROCKWEEDS - *FUCUS GARDNERI/ HESPEROPHYCUS CALIFORNICUS*						
SLENDER ROCKWEEDS - *PELVETIOPSIS LIMITATA/ SILVETIA COMPRESSA*						
ENCRUSTING CORALLINE ALGAE (ON ROCKS) - MANY SPECIES						
UPRIGHT CORALLINE ALGAE - *BOSSIELLA SPP./ CALLIARTHRON/CORALLINA SPP.*						
RED ALGAL TURF - *ENDOCLADIA MURICATA AND GELIDIUM COULTERI*						
TURKISH TOWEL - *MASTOCARPUS PAPILLATUS*						
IRIDESCENT ALGAE - *MAZZAELLA FLACCIDA/ SPLENDENS*						
AGGREGATING ANEMONE (<5 CM) - *ANTHOPLEURA ELEGANTISSIMA*						
LIMPETS - *LOTTIA SPP./MACCLINTOCKIA SPP. (0.5 - 2.5 CM)*						
SEA MUSSEL - *MYTILUS CALIFORNIANUS*						
COMMON ACORN BARNACLES - *BALANUS/ CHTHAMALUS SPP.*						
BARE ROCK						

Rocky Reef/Subtidal Data Sheet

PLACE CENTER OF QUADRAT OVER THE PHOTO QUADRAT

	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID	
	A	B	C	D	
DEPTH	110 M	86 M	42 M	42 M	
INDIVIDUALS – COUNT IF ANY PORTION OF THE ANIMAL IS IN THE 1/4 M2 QUADRAT.					**NOTES**
ORANGE CUP CORAL	2	2	9	4	
UPRIGHT HYDROCORAL	0	0	0	3	
SEASTAR	0	2	1	0	
CRINOIDS	4	3	0	0	
UNIDENTIFIED SPECIES					
COUNT AND RECORD THE NUMBER OF SQUARES OUT OF SIX WITH ANY ATTACHED PIECE OF:					
STRAWBERRY ANEMONES	0	6	6	6	
SPONGE	0	5	4	6	
BARE ROCK	6	6	0	0	

Rocky Intertidal Data Sheet Answers

	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID	PHOTO ID
	1	2	3	4	5	6
INDIVIDUALS - COUNT IF ANY PORTION OF THE ANIMAL IS IN THE PHOTO QUADRAT.						
GIANT GREEN ANEMONE - *ANTHOPLEURA XANTHOGRAMMICA*	0	0	0	0	0	0
CHITONS - *MOPALIA SPP./NUTTALLINA CALIFORNICA/ LEPITOCHITONA SPP.*	0	0	0	0	0	0
WHELKS - *ACANTHINUCELLA SPP./NUCELLA SPP.*	0	1	0	0	0	18
TURBAN SNAILS -*TEGULA BRUNNEA/FUNEBRALIS*	1	37	0	23	40	0
COUNT AND RECORD THE # OF SQUARES OUT OF SIX WITH ANY ATTACHED PIECE OF:						
GREEN PIN-CUSHION ALGA - *CLADOPHORA COLUMBIANA*	0	1	0	0	0	0
SEA LETTUCES - *ENTEROMORPHA/ULVA SPP.*	0	0	0	0	0	0
FLATTENED ROCKWEEDS - *FUCUS GARDNERI/ HESPEROPHYCUS CALIFORNICUS*	3	0	1	0	0	0
SLENDER ROCKWEEDS - *PELVETIOPSIS LIMITATA/ SILVETIA COMPRESSA*	0	0	0	0	0	0
ENCRUSTING CORALLINE ALGAE (ON ROCKS) - MANY SPECIES	0	5	0	6	6	6
UPRIGHT CORALLINE ALGAE - *BOSSIELLA SPP./ CALLIARTHRON/CORALLINA SPP.*	0	0	0	0	0	1
RED ALGAL TURF - *ENDOCLADIA MURICATA AND GELIDIUM COULTERI*	0	0	0	0	2	5
TURKISH TOWEL - *MASTOCARPUS PAPILLATUS*	0	0	0	0	0	0
IRIDESCENT ALGAE - *MAZZAELLA FLACCIDA/ SPLENDENS*	5	0	5	0	0	2
AGGREGATING ANEMONE (<5 CM) - *ANTHOPLEURA ELEGANTISSIMA*	0	6	0	1	5	0
LIMPETS - *LOTTIA SPP./MACCLINTOCKIA SPP. (0.5 - 2.5 CM)*	1	0	0	0	0	0
SEA MUSSEL - *MYTILUS CALIFORNIANUS*	0	0	0	0	0	0
COMMON ACORN BARNACLES - *BALANUS/ CHTHAMALUS SPP.*	6	2	2	1	0	0
BARE ROCK	6	6	5	6	3	6