Deep East 2001 Exploration

Living in Extreme Environments: Havens on the Deep Sea Floor

Focus
Biological Sampling Methods

Grade Level
9-12

Focus Questions
1. What are the characteristics of an extreme environment in the deep ocean?
2. Explain what YOU would need in order to survive in this environment?
3. Why do people want or need to study and learn more about extreme environments in the deep ocean?
4. What three things must all populations of organisms be capable of doing in order to survive?
5. What types of data will scientist be collecting in the extreme environments visited during the Mountains in the Sea: Exploring the New England Seamount Expedition.

Learning Objectives
Students will understand the use of four methods commonly used by scientists to sample populations.

Students will understand how to gather, record, and analyze data from a scientific investigation.

Students will begin to think about what organisms need in order to survive (collect food, grow, protect themselves, and successfully reproduce).

Students will understand the concept of interdependence of organisms.

Adaptations for Deaf Students
Vocabulary:
Benthic
Substrate

Teaching Time:
Three 45-minute periods

Materials
For each group of 3 or 4 students:
- ❒ String (40 cm in length), round paper dots (from waste bin of a 3-hole punch), 4 toothpicks, glue
- ❒ Photo of the deep-sea habitat
- ❒ Descriptions of the four sampling methods and instructions on how to use them
- ❒ One "Key for Organisms"
- ❒ Deep Sea Environment Procedure Data Sheet (one for each student in each group)
- ❒ Student Evaluation Sheet (one for each student in each group)
- ❒ Ecology textbooks to use for reference
- ❒ Metric rulers
- ❒ Masking tape
- ❒ Colored fine point marker or pen
- ❒ Clear transparency paper

Teaching Time
One or two 45-minute periods

Seating Arrangement
Groups of three to four students

Key Words

Biomass
Chemosynthesis
Core samples
Ecotone
Gas hydrates
Infauna and epifauna
Line transect
Point survey
Interstitial
Methane
Octocorals
Quadrat
Seepage
Symbiosis
Morphology
Baseline
Coral polyps
Metabolic pathways

Background Information

In order to survive, organisms must: 1) have access to some source of energy for metabolism (food, light, chemicals), 2) successfully defend themselves against predators and environmental stress, and 3) make more of their own kind or reproduce. How do they accomplish these requirements? Even thousands of years ago, before explorers had access to what we consider primitive instrumentation and ocean-going vessels, these questions were being raised.

The deep-sea benthos comprises a large and important marine habitat that we know relatively little about. The type of substrate strongly influences the species composition of a benthic community. Today, we have sophisticated technological capabilities that have made the ocean more "visible" and more accessible than it has ever been before. As a result of "new technological eyes," hundreds of new species, e.g., the Gulf of Mexico Iceworm, *Hesiocaca methanicola*, and new ecosystems have been discovered. Some of these new discoveries may hold the keys to the origin(s) of life on Earth, cures to life-threatening diseases, and knowledge about presently-unknown metabolic pathways for obtaining and using energy to support life on Earth.

During Deep East 2001, scientists will be collecting information about three specific locations off the East Coast of North America. Leg One will investigate the deep sea coral communities (epifauna) in the Georges Bank Canyons. Leg Two will explore the deep sea processes and sediment infauna of Hudson Submarine Canyon. Leg Three will investigate gas hydrates and mussel beds (epifauna) on the Blake Ridge.

Scientists will be collecting data on the size class and distribution of deep sea organisms to compare one population with another and/or study the same population over time. Scientists collect information about the size of individual deep-sea coral polyps and/or the coral bed as a whole. Size can be recorded as height or diameter of individual polyps and/or surface area and/or biomass of the coral bed within a specified area or along a transect. Scientists will record the species and class of corals by looking at the morphology (shape and structure) of individual coral polyps as well as the entire coral bed's structure and will collect information about individual polyp and coral bed locations to determine their overall distribution. Scientists also will use several methods to survey each site to determine population densities and other pertinent information.

This data is important because we need to make baseline descriptions of a community to use as a standard for comparison. By collecting the same kinds of information over a period of months or years, scientists determine if changes in size, class, density and distribution of populations have taken place. Only then will we know if something might be impacting that ecosystem. For example, if we find there are fewer smaller coral colonies in the same place than recorded earlier, this could indicate some type of disturbance (fishing gear, waste disposal, or slumps) to the older and larger polyps, replacing older with younger (smaller) corals.

Is a disease or new predator affecting the coral bed, and if so, why? The new data gathered as scientists explore the unknown deep-sea corals off the Georges Bank, the infauna of the sediments of Hudson Canyon, and the mussel beds of Blake Ridge will lead to many new questions and hopefully some new answers to old questions as well.

Learning Procedure

1. Students will individually write answers to Focus Questions on the Data and Answer Sheet.
2. Teacher will divide the class into groups of 3 or 4 students each.
3. Teacher will hand out a photo, a transparency, and a "Key to Organisms" Sheet to each group. A Data and Answer Sheet will be given to EACH student.
4. Each group will read about the four different methods of sampling populations (Line Transect, Core Sample, Quadrat, and Random Point Survey).
5. Groups will use a different sampling method on the photo. One method (Core Sample) will not be used. Students will follow the procedure for each sampling method on the photo.
6. Students will record the method, names, and numbers of organisms observed during "sampling" for each of the 3 trials (raw data).
7. Students will average the three trails to get an average set of data and record the average on the Data and Answer Sheet. To obtain the average, total the number of each species for each trial, then divide by the number of trials (3). If no individuals of a species are observed in a trial, use a zero for that species number.
8. Students will generate a chart or graph for the data, giving it a title and all other appropriate labels and keys. Three charts or graphs may be generated or a group may choose to combine all data into one chart or graph.
9. Each group will have five minutes to prepare and one minute to present a summary of its findings to the entire class.
10. Teacher will lead a discussion on whether groups had similar or differing conclusions, with possible explanations for results generated by the students. (There are no right or wrong answers because no one knows!)
11. Students will individually answer evaluation questions on the Data and Answer Sheet in class or for homework.

The BRIDGE Connection

www.vims.edu/bridge/plankton.html
/archives
/benthos
/geology

The "Me" Connection

The discovery of new life forms may hold the keys to the origin(s) of life on Earth, cures to life-threatening diseases, and knowledge about presently- unknown metabolic pathways for obtaining and using energy to support life on Earth.

Connection to Other Subjects

Mathematics, English/Language Arts, Physical, Earth, and Biological Science, Art/Design

Evaluation

Use Student Evaluation Sheet

Extensions

- Ask students to write a story based on the lesson, projecting themselves into the storyline.
- Ask students to act as if they were the pilot operating a deep sea submersible.
- Ask students to create a "survival kit" for their deep-sea mission.
- Ask students to investigate technologies of the past used in previous ocean exploration initiatives.
- Ask students to investigate career opportunities as ocean explorers, ocean scientists, and others whose careers support ocean science research and exploration.
- Visit the Ocean Exploration Web Site at www.oceanexplorer.noaa.gov
- Visit the National Marine Sanctuaries web page for a GIS fly-through of the Channel Islands

National Marine Sanctuary at www.cinms.nos.noaa.gov/

National Science Education Standards

Science as Inquiry - Content Standard A:
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Life Science – Content Standard C
- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

Earth and Space Science – Content Standard D
- Structure of the Earth system

Science and Technology – Content Standard E:
- Understandings about science and technology
- Abilities of technological design

Science in Personal & Social Perspectives – Content Standard F:
- Population growth
- Personal and community health
- Natural resources
- Environmental quality
- Natural and human-induced hazards

History and Nature of Science – Content Standard G:
- Science as a human endeavor
- Nature of science

For More Information

Paula Keener-Chavis, National Education Coordinator/Marine Biologist
NOAA Office of Exploration
Hollings Marine Laboratory
331 Fort Johnson Road, Charleston SC 29412
843.762.8818
843.762.8737 (fax)
paula.keener-chavis@noaa.gov

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http://oceanexplorer.noaa.gov

Student Handout

Line Transect Sampling Methodology

Line Transect (Linear Point-Intercept Transect):

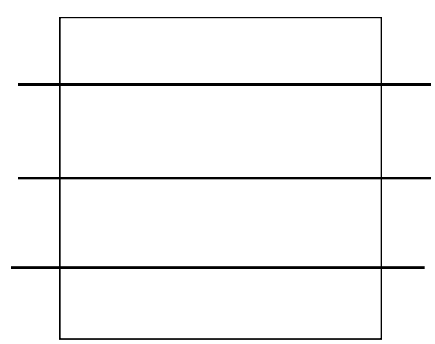
Line Transects (more technically referred to as linear point-intercept transects) are used to determine what organisms are found on an ocean bottom or in a substrate. Several lines are laid to ensure maximum characterization of the study area. Suppose the leader of a far away galaxy told her astronauts to go to planet Earth and bring back a sample of what Earth is like. If they brought back a sample from only one or two different locations on Earth, would the leader have a good picture of what the Earth is really like? (Think: ocean, coral reef or deep-sea coral bed, mud flat, city, desert, ice cap, mountain top, pine forest, redwood forest, river, lake, beach, parking lot, sewage pond, suburb, amusement park, football field, and a golf course). Often the data is inaccurate even though many samples are taken to get a more accurate picture of what is there. Inaccuracies may occur due to lack of direct access to the environment, problems with the sampling methods, or difficulties identifying the organisms.

To Make a Line Transect Instrument:

1. Cut a piece of string 40 cm long (string may be pre-cut by teacher).
2. Using a metric ruler, mark regularly-spaced points every 2 cm along the string where each observation will be made.

To Use a Line Transect on the Transparency Covering the Photo:

1. Place a clear transparency over the photo and tape it in place.
2. Place the marked string across the photo left to right, 4 cm from the top of the photograph, taping it on the ends outside the picture with masking tape.
3. Using the colored pen or marker, place a dot on the transparency over the photograph by each marked 2 cm on the string.
4. Using the Key for Organisms, identify and record the name of each organism directly beneath the dot marked on the transparency over the photograph. Record as raw data on the Data and Answer Sheet.
5. Repeat Steps #1- 4 two more times placing the starting and ending points of the string 4 cm lower on the photo each time keeping the string parallel to its previous location. You will end up with data for three trials of the Line Transect crossing different areas on the photo.
6. Average the three trials for a more accurate set of data. Record the average on the Data and Answer Sheet (see #7 under Learning Procedure).



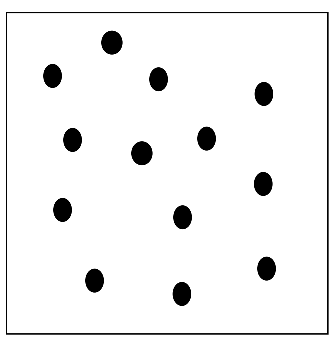
Student Handout

Random Point Survey Sampling Methodology

Random Point Survey:
A random point survey uses randomly-selected points in a study area to characterize a site. The more points surveyed, the more accurate the data.

Procedure to Conduct a Random Point Survey:

1. Obtain 12 punched out dots from the three-hole punch waste bin.
2. Hold each dot about one foot above the chosen photo and drop it. If it does not fall on the photo, try again. When you are done there should be 12 dots randomly scattered across the photo. (Be careful not to breathe hard on the dots until the spots are marked on the photo!)
3. Mark the position of each dot with the colored pen or marker.
4. Using the "Key for Organisms," identify and record the name of organisms found under each dot. Record as raw data on the Data and Answer Sheet.
5. Repeat Steps #2 – 4 two more times to finish the three trials of the Random Point Survey.
6. Average the three trials for a more accurate set of data. Record average on the Data and Answer Sheet (see #7 under Learning Procedure).



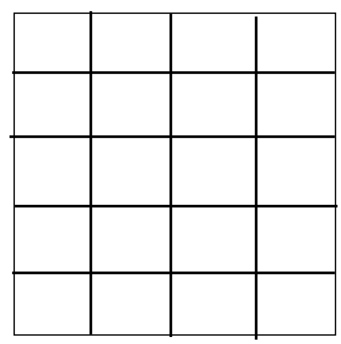
Student Handout

Quadrat Survey Sampling Methodology

Quadrat:
A quadrat survey is another systematic approach to characterizing a study area. The study area is separated into smaller equal sections or quadrat. The investigator will record all organisms found in a specified number of sections of each quadrat.

Procedure to Conduct a Quadrat Study:

1. Divide the study area into squares of 2 cm each.
2. Randomly choose 3 squares for study. You may drop dots, label each quadrat with a number and randomly choose numbers, or devise your own method for random choice.
3. Using the Key for Organisms, identify and record the names of all organisms found in each of the four quadrats. Record as raw data on the Data and Answer Sheet.
4. Repeat Steps #2 – 3 two more times to finish the three trials of the Quadrat Survey.
5. Average the three trials for a more accurate set of data. Record the average on the Data and Answer Sheet (see #7 under Learning Procedure).



Core Sampling Methodology

Core Sample:
A core sample is obtained by inserting a hollow tube-shaped device into the bottom sediments to retrieve a tube full of sediment with its accompanying organisms. Animals small enough to live between individual grains of sediment are called the interstitial community. Organisms like worms, crustaceans, bacteria, and protozoans are found here. Larger organisms also live at or below the surface of the sediment, many with some type of structure that protrudes above the surface of the sediments to collect food, dispose of wastes, respire, and/or reproduce. To collect a core sample, scientists push the Core Sampler into the sediment to the desired depth. The core sampler is retrieved. Scientists analyze the sample (usually using a microscope) and record data.

Student Handout

Deep Sea Environment Procedure Data Sheet

Line Transect Sampling Methodology

Trial One - __________

Trial Two - __________

Trial Three - __________

Average of 3 Trials __________

Random Point Survey Sampling Methodology

Trial One - __________

Trial Two - __________

Trial Three - __________

Average of 3 Trials __________

Quadrat Survey Sampling Methodology

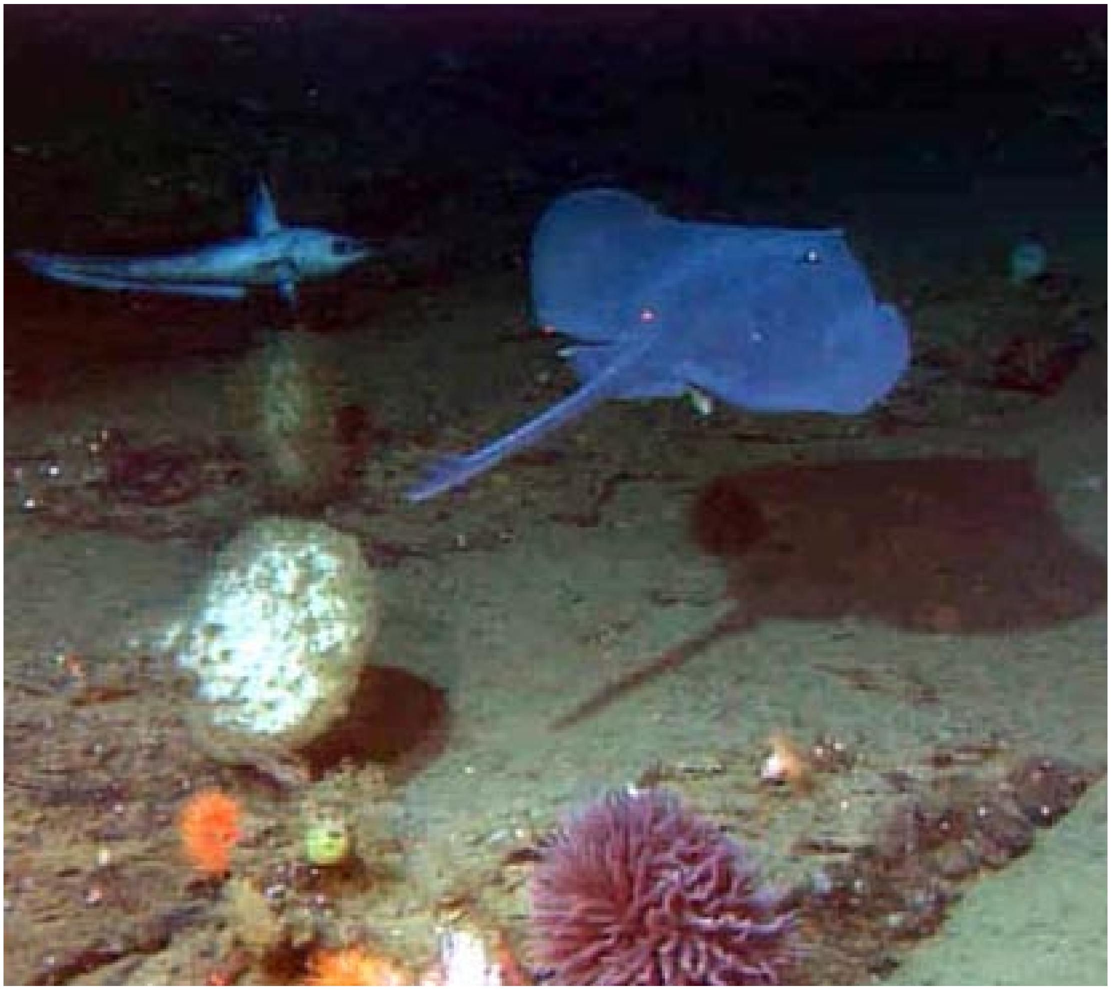
Trial One - __________

Trial Two - __________

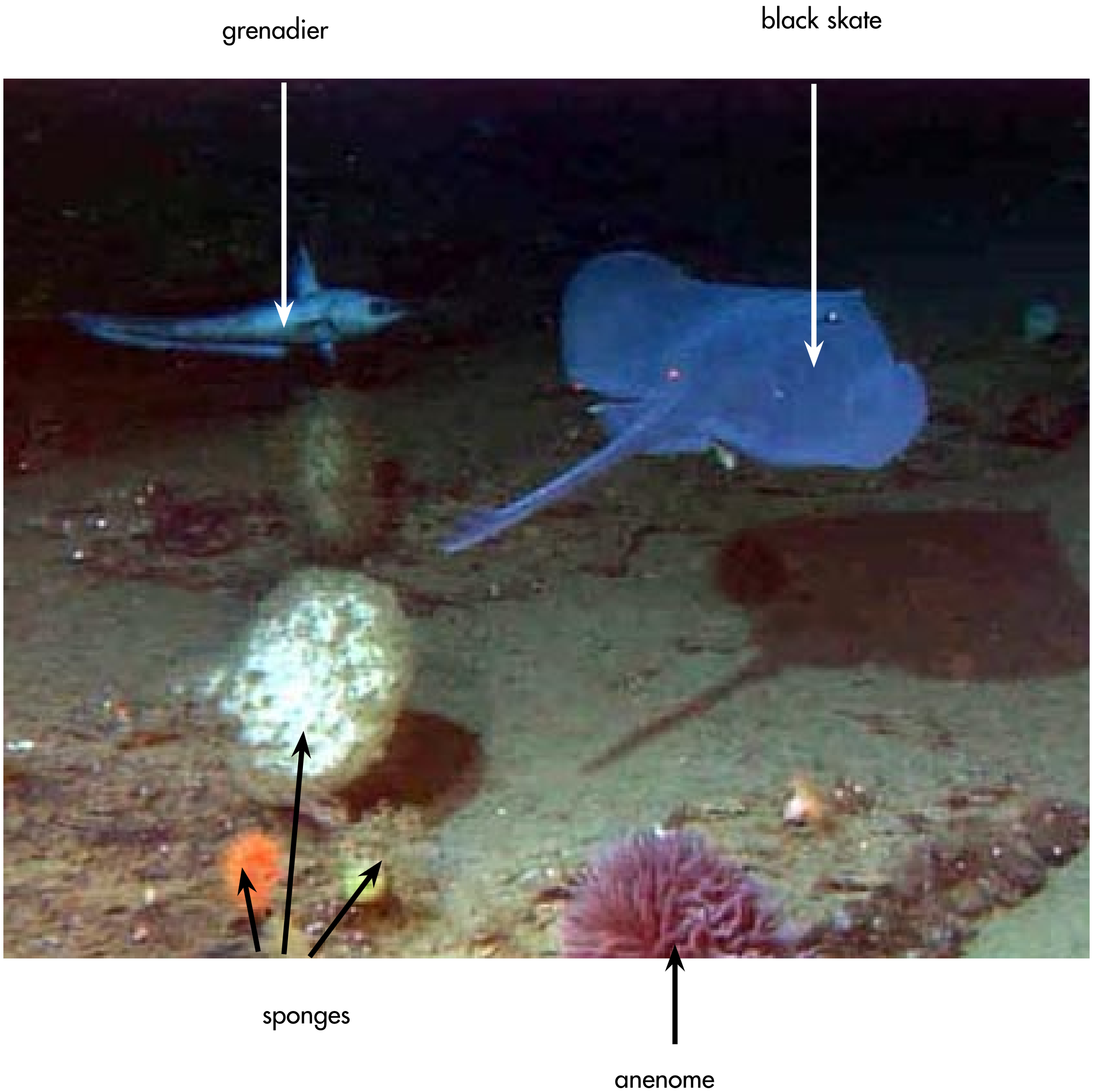
Trial Three - __________

Average of 3 Trials __________

Student Handout



Student Handout



Student Handout

Student Evaluation Sheet

1. What three things must all populations of organisms accomplish successfully in order to survive?

2. Why do scientists always perform three or more trials when gathering data?

3. What are some of the problems associated with studying deep-sea organisms?

4. What are some of the problems you might encounter bringing a deep-sea organisms to the surface for study? Be specific.

5. Why are species of organisms found in one location and not in another? (b) Why are no plants found in deep-sea environments?

6. Do you think environmental change tends to increase or decrease diversity?

7. Do you think organisms found in high or low diversity environments would be more likely to survive change? Explain your reasoning.

8. Write a paragraph (5-7 sentences) based on what you have learned in this activity, describing how your newly-acquired deep-sea knowledge about the deep sea might make a difference in your life 10 years from now.

Student Handout

Student Evaluation Sheet
Teacher Answer Key

1. To get food or other energy necessary for metabolism and growth, defend themselves from predators, and successfully reproduce.

2. To try to get more accurate data.

3. Sampling tool must be functional, incorrect estimates of individuals and/or diversity of individuals, how to determine exact location of studied sample site, expense, too deep for SCUBA, etc. Accept all reasonable answers.

4. How to catch it, how to transport it, pressure change, temperature change, keeping it alive, food for it, etc. Accept all reasonable answers.

5. a. Different species have different requirements for food, temperature, substrate, light, and other factors. Accept all reasonable answers.
   b. Because plants need light in order to photosynthesize to make food.

6. It depends on the type of environmental change.

7. High diversity environments offer more survival strategies. Answers will vary.

8. Answers will vary.