U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service

Lesson 18: Invertebrates

Overview

Lesson 18 provides a survey of common marine invertebrates including sponges, corals, lobsters, crabs and sea stars. It provides students with the basic taxonomy of major invertebrate phyla. In the activity, students demonstrate different sampling methods used to study the ocean using a photo of a deep sea community. Students compare different sampling techniques and identify challenges to surveying marine life.

Lesson Objectives

Students will:

1. Describe characteristics of major marine invertebrate phyla
2. Identify examples of organisms from each phylum
3. Demonstrate three ocean sampling techniques

Lesson Contents

1. Teaching Lesson 18
    a. Introduction
    b. Lecture Notes
    c. Additional Resources
2. Teacher's Edition: Sampling the Deep Sea Floor
3. Student Activity: Sampling the Deep Sea Floor
4. Student Handout
5. Mock Bowl Quiz

Standards Addressed

National Science Education Standards, Grades 9-12
Science as inquiry
Life science

Ocean Literacy Principles
The ocean supports a great diversity of life and ecosystems

DCPS, High School
Environmental science
E.1.2. Know that scientists cannot always control all conditions to obtain evidence, and when they are unable to do so for ethical or practical reasons, they try to observe as wide a range of natural occurrences as possible so as to be able to discern patterns

Lesson Outline[1]

I. Introduction

At the beginning of the lesson, invite a few students to share the taxonomy of their favorite marine organism (the assignment given in the previous class). If any students picked an invertebrate, you may want to point out the phylum and class for students to remember as you go through the PowerPoint.

II. Lecture Notes

Present the lecture material using the PowerPoint for Lesson 18 (File:Lesson 18 – Invertebrates). Distribute the Student Handout so that students can take notes as you lecture.

III. Additional Resources

1. Ocean Explorer Deep East Lesson Plans
   http://oceanexplorer.noaa.gov/explorations/deepeast01/background/education/meplans.html

[1] Unless otherwise indicated, all websites provided or referenced were last accessed in November 2010.

Sampling the Deep Sea Floor

Overview
In this activity, students read about three different sampling methodologies commonly used by scientists to assess species diversity in marine ecosystems. Students simulate each sampling method using a photo of a coral community and answer related questions.

This activity is adapted from the NOAA Ocean Explorer lesson plan "Living in Extreme Environments: Havens on the Deep Sea Floor," available at the following website: http://oceanexplorer.noaa.gov/explorations/deepeast01/background/education/dehslessons5.pdf.

Background
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 ocean expeditions, scientists collect data on the size class and distribution of deep sea organisms, many of which are invertebrates, 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[2]. Scientists record the species and class of corals by

A scientist samples along a transect to assess coral reef populations

Photo: NOAA

[2] Photo: http://www.pifsc.noaa.gov/cruise/ha1008.php

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 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[3]. 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.

Scientists can tell how populations change by repeatedly sampling the same transects. These data collected from a sampling site in Michigan show how plant and algal populations change over time.

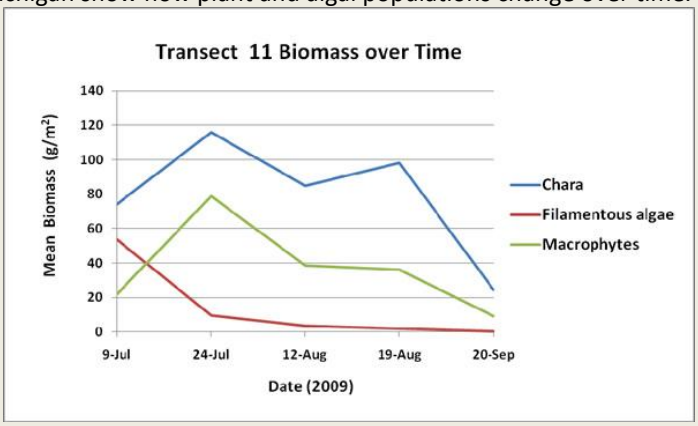

Photo: NOAA

In this activity, students simulate some of the different sampling methods scientists use during deep sea expeditions to sample deep sea invertebrates.

Materials

- String (40cm in length), one per student
- Round paper dots (from waste bin of a 3-hole punch)
- 4 toothpicks
- Glue
- Metric rulers, one per group
- Masking tape
- Colored fine point marker or pen, one per group
- Clear transparency paper, one per group

Procedure

1. Divide your class into groups of 4-5 students per group.
2. Distribute a photo, transparency, organism key, data and answer sheet to each group.
3. Students will read about three different methods of sampling populations (Line Transect, Quadrat and Random Point Survey).
4. Students will follow the procedure for each sampling method on the Photo.

[3] Photo: http://www.glerl.noaa.gov/res/projects/multi_stressors/project_updates

5. Instruct students to record the names and numbers of organisms observed using each method. The Organism Key provides students with the common name for each organism. Students should write the taxonomy up to the phylum level for each organism.
6. Students will record the average of all three trails for each method.
7. Students will answer the questions provided.

Answer key

1. What three things must all populations of organisms accomplish successfully in order to survive?
   To get food or other energy necessary for metabolism and growth, defend themselves from predators and successfully reproduce.

2. Why do scientists ideally perform more than one trial when gathering data?
   To try to get more accurate data.

3. Did all three sampling methodologies produce the same results? Why or why not?
   Answers vary.

4. What are some of the methodological problems associated with studying deep water organisms?
   Sampling tool must be functional; incorrect estimates of individuals and/or diversity of individuals; difficult to determine exact location of studied sample site; expense; too deep for SCUBA. Accept all reasonable answers.

5. What are some of the problems you might encounter bringing a deep water organisms to the surface for study? Be specific.
   How to catch it; how to transport it; pressure change; temperature change; keeping it alive; feeding it. Accept all reasonable answers.

6. Why are species of organisms found in one location and not in another? Why aren't plants found in deep water environments?
   Different species have different requirements for food, temperature, substrate, light and other factors. Plants need light in order to photosynthesize to make food. Accept all reasonable answers.

7. Do you think environmental change tends to increase or decrease diversity? Why?
   It depends on the type of environmental change.

8. Do you think organisms found in high or low diversity environments would be more likely to survive change? Explain your reasoning.
   High diversity environments offer more survival strategies.

Sampling the Deep Sea Floor – A Case Study with Invertebrates

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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.

A scientist samples along a transect to assess coral reef populations

Photo: NOAA

During ocean expeditions, scientists collect data on the size class and distribution of deep sea organisms, many of which are invertebrates, 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 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 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.

Scientists can tell how populations change by repeatedly sampling the same transects. These data collected from a sampling site in Michigan show how plant and algal populations change over time.

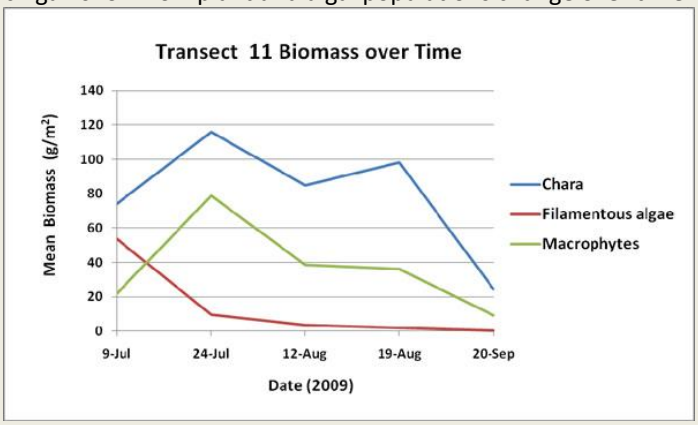


Photo: NOAA

Today, you are going to simulate some of the different sampling methods scientists use during deep sea expeditions to sample deep sea invertebrates.

Materials

- String (40cm in length),
- Round paper dots (from waste bin of a 3-hole punch)
- 4 toothpicks
- Glue
- Metric rulers
- Masking tape
- Colored fine point marker or pen
- Clear transparency paper

Procedure

1. Obtain a photo, transparency, organism key, data and answer sheet from your teacher.
2. In your group, read about the four different methods of sampling populations (Line Transect, Quadrat and Random Point Survey).
3. Follow the procedure for each sampling method on the Photo.
4. Record the names and numbers of organisms observed using each method. The Organism Key provides you with the common name for each organism. Write the taxonomy up to the phylum level for each organism.
5. Record the average of all three trails for each method.
6. Answer the questions provided.

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

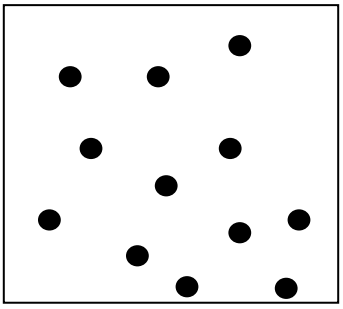
To Use a Line Transect on the Transparency Covering the Photo:

1. Place a clear transparency over the photo and tape it in place.
2. Place the marked string across the photo left to right, 4cm 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 2cm 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).

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.

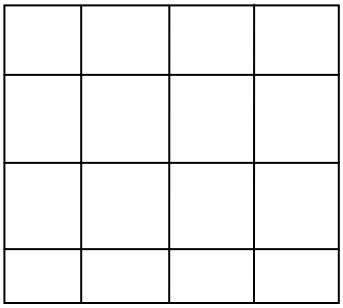
Procedure to Conduct a Random Point Survey:
1. Obtain 12 punched out dots from the three-hole punch waste bin.
2. Hold each dot about one foot above the chosen photo and drop it. If it does not fall on the photo, try again. When you are done there should be 12 dots randomly scattered across the photo. (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).



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 2cm 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).



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 _____

Questions

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

2. Why do scientists ideally perform more than one trial when gathering data?

3. Did all three sampling methodologies produce the same results? Why or why not?

4. What are some of the problems associated with studying deep water organisms?

5. What are some of the problems you might encounter bringing deep water organisms to the surface for study? Be specific.

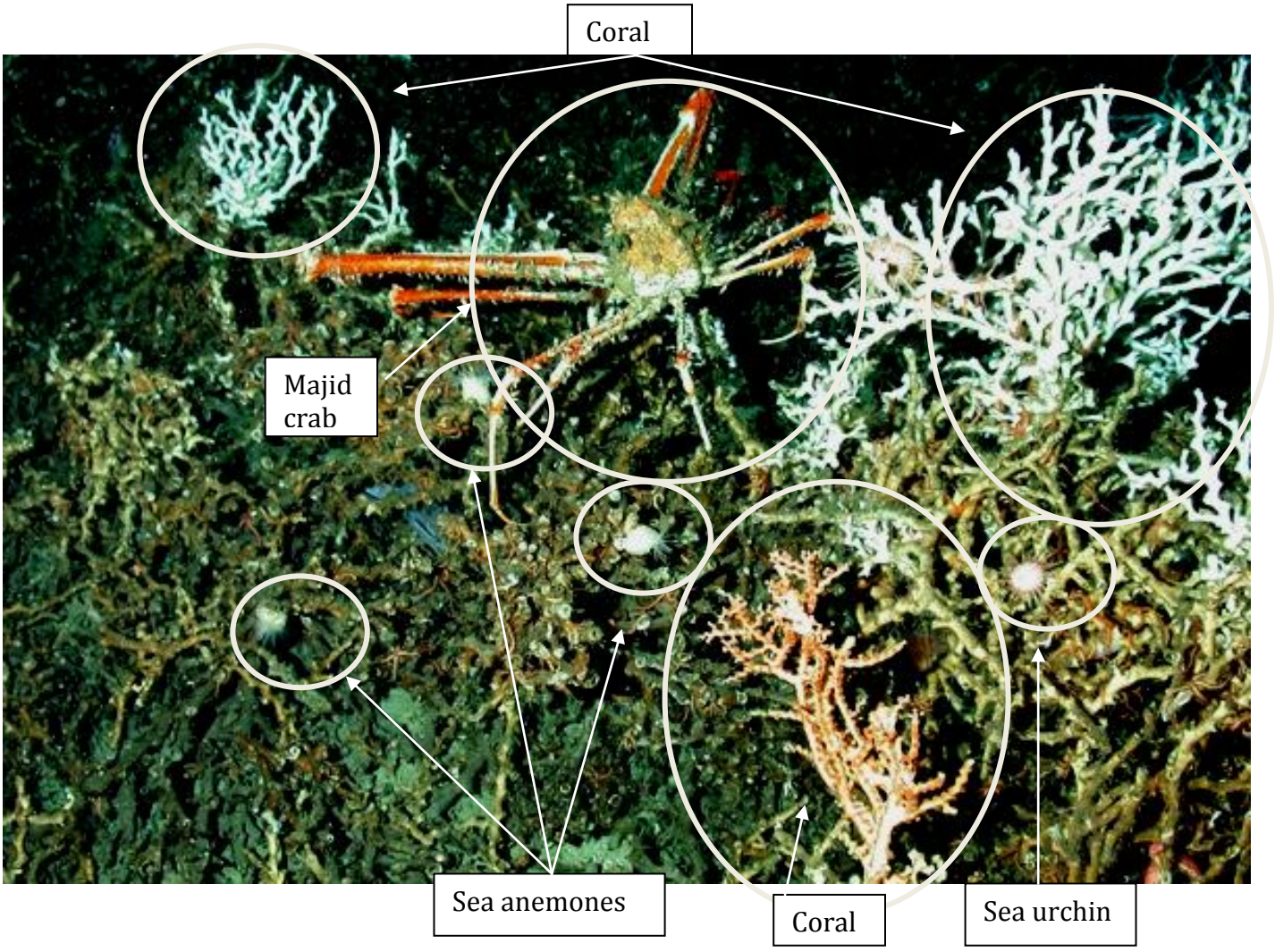
6. Why are species of organisms found in one location and not in another? Why aren't plants found in deep water environments?

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

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

Photo

Organism Key



Tips for the Bowl - Marine Invertebrates

For the NOSB, make sure you are familiar with the following marine invertebrate phyla! You should be able to identify at least the phyla of common marine species and understand how they are related to one another (e.g., know that a lobster is more closely related to a copepod than to an oyster).

Classification Overview
Common Invertebrates

Kingdom
Animalia

Phlyum
Porifera
Cnidaria
Mollusca
Arthropoda
Echinodermata

During your teacher's lecture, write down common features and some examples for each phylum listed below.

Porifera	Cnidaria
Mollusca	Arthropoda
Echinodermata	

Invertebrates

1. Sponges belong to which of the following phyla?
    w. Cnidaria
    x. Echinodermata
    y. Chysophyta
    z. **Porifera**

2. Which of the following characteristics is common to Cnidarians?
    w. **Nematocysts**
    x. Radula
    y. Foot
    z. Antennae

3. Which of the following is **not true** of the Portuguese Man-of-War?
    w. It is a colony of specialized polyps
    x. It is in the order Siphonophora
    y. It is a Cnidarian
    z. **It is a species of jellyfish**

    Teacher's Note: Jellyfish belong to the Cnidarian class Scyphozoa, whereas the Man-of-War is in the class Hydrozoa.

4. Which of the following is the phylum of a copepod?
    w. Echinodermata
    x. **Arthropoda**
    y. Copepoda
    z. Decapoda

5. A sea star is:
    w. **An Echinoderm**
    x. A Cnidarian
    y. A Poriferan
    z. A Crustacean

6. Which statement is true of an octopus and an oyster?
    w. They are in different phyla
    x. They are in different kingdoms
    y. They are in the same order
    z. **They are in different classes**

7. Short answer: This term refers to a muscular bag surrounding the gills and other organs of a mollusk
    Answer: Mantle

8. Short answer: The fire coral belongs to which class?
   Answer: Hydrozoa

9. Which is not a characteristic of a crustacean?
   w. Jointed exoskeleton
   x. Mandibles
   y. **Radial symmetry**
   z. Two pairs of antennae

10. Team challenge question

 [4]

1. What are the phylum and class of the octopus shown above? (2pt)

2. The tentacles of the octopus are actually a modified version of what common feature of its phylum? What is their function? (2pt)

3. What are two features common to this phylum? (2pt)

4. Name one organism in the same class as the octopus and another in the same phylum. (2pt)

[4]Photo: NOAA, http://oceanexplorer.noaa.gov/explorations/02fire/logs/jul31/media/octopus.html

ANSWER

 [5]

1. What are the phylum and class of the octopus shown above? (2pt)
   Mollusca (1pt), Cephalopoda (1pt)

2. The tentacles of the octopus are actually a modified version of what common feature of its phylum? What is their function? (2pt)
   The foot (1pt), movement (1pt)

3. What are two features common to this phylum? (2pt)
   A mantle and a radula (2pt)

4. Name one organism in the same class as the octopus and another in the same phylum. (2pt)
   Answers vary: squid is in the same class; oysters, clams, snails and sea slugs are some examples in the same phylum

[5]Photo: NOAA, http://oceanexplorer.noaa.gov/explorations/02fire/logs/jul31/media/octopus.html