Guided Inquiry Activity:
Exploring benthic infauna: A habitat comparison

Teacher Notes

Grades: 6-8

Timeline: Two to three 40-minute class periods

Issue or Problem: Many of the nation's estuaries are high population, high use areas. As the number of people and the level of activity increases, discharge of nutrients and other pollutants can alter estuary ecosystems. Communities of infaunal species - those that live in the sediment at the bottom of an estuary - can be important indicators of the health of ecosystems there. Scientists and decision-makers in many coastal communities are searching for keys to problems such as hypoxic (very low oxygen) events that may be connected to nutrient levels.

Core Question: What comparisons can we draw between communities of organisms and the environments in which they live?

Objectives

- Students will compare the fauna living in the sediments of two different locations.
- Students will make connections between biological communities and their physical and chemical environments
- Students will think about human impact on chemical and physical environments
- Students will explore how scientists might use information on numbers and species of benthic infauna to investigate the health of an ecosystem.

Background Information for Teachers

In the sediments of bodies of water live a variety of organisms, ranging from microscopic to larger animals such as clams. Collectively, these organisms are known as the infauna – those that live *in* the sediments. The types of infauna found in a given area may be determined by the sediment size, food availability, nutrient input, level of disturbance, oxygenation of the sediments, and the animals' own pollution tolerance, among other factors. These factors will affect both species diversity and abundance.

This activity focuses on Narragansett Bay, a shallow estuary in Rhode Island. At the northern end of the bay is the capital, Providence, with a population of 100,000 people and numerous industries. The state's largest sewage treatment plant discharges an average of 42 million gallons of treated sewage per day into the upper Providence River, the upper part of Narragansett Bay. Each year, billions of gallons of untreated wastewater also enter the bay and its tributaries from combined sewer overflows (see References below for more information). The nutrients from sewage can cause oxygen depletion by first spurring growth of algae and phytoplankton in the water. When the additional algae and phytoplankton eventually die, bacteria multiply because dead algae

is a great food source. These bacteria require oxygen and therefore reduce the amount of oxygen available in the water.

Traveling south in the bay, toward the mouth, population and human activity decreases, although it is important to keep in mind that Rhode Island is still the second most densely populated state in the country.

The environment of the bottom and oxygen levels at the bottom overall tend to change toward the mouth of the bay. The photographs below show two profiles of the sediment for comparison. The pictures and information are from the Discovery of Estuarine Environments web site (see References).

Sediment-profile image from the lower Providence River near Conimicut Point showing degraded benthic habitat quality. In this image, a relatively thin surface layer of lighter-colored, oxidized sediment overlies black, anoxic sediment at depth. Anoxic sediments having a thin redox layer occur in typical in areas with high rates of organic loading and periodic low dissolved oxygen levels in near-bottom waters. The white shells near the sediment surface are numerous individuals of the opportunistic bivalve *Mulinia lateralis* (little surf clam). Courtesy SAIC, Newport, RI

Sediment-profile image from the West Passage of lower Narragansett Bay showing relatively healthy benthic habitat quality. The image shows well-oxygenated, sandy mud sediments, with a large burrow structure at depth indicating the presence of larger benthos (e.g., lobster) Courtesy SAIC, Newport, RI.

Note to teachers:
This activity is a simulation of a laboratory in which students examine benthic samples from two different areas of Narragansett Bay. It is based on an actual science lab done in the spring of 2005 by students at Thompson Middle School in Newport, Rhode Island. The selection of organisms provided in this activity is based on those that were actually found by the students. A more authentic lab experience can, of course, be gained by obtaining your own sediment samples. See Notes at the end of the activity.

Materials

Introduction and data

Life-size pictures of organisms (File: Benthic Organism Photos)
Maps of Narragansett Bay and the sampling areas (File: Map – Bullock and Fox)
Sediment area profile photos (File: Sediment Profiles or web site: Discovery of Estuarine Environments)

For the class

Pictures of organisms from Fox Island and Bullock's Reach, printed on card stock and cut out (be sure to keep them separate by location)
2 containers, one labeled "Bullock's Reach" and the other labeled "Fox Island," each with 1.5-2 liters of **dry** ground coffee (simulated "sediments")

For each group of students:

1 sieve or kitchen strainer
3 Dixie cups or small beakers
Forceps (optional)
Paper plate
1 sheet colored paper
Lots of newspaper

Key (File: Benthic Organism Key)
Lab Sheet (File: Benthic sampling lab sheet simulation)

Preparation

Place the cut-out pictures of benthic organisms in the appropriate containers for their location. Mix up the "sediments" (coffee) so the pictures are fairly well hidden.

Method

Begin by showing students a map of Rhode Island or Narragansett Bay (File: RI Satellite Photo or see On-Line Resources). Give students a few minutes to look at the map and make observations. A discussion of the map might include: Is this body of water fresh, salt, or a combination? Where would the sources of fresh and salt water be? Where is the most populated area? Where would shipping lanes likely be?

What kind of animals might live in Narragansett Bay? Would different things perhaps live in different parts of the bay? Brainstorm a list of factors that might affect what lives in an area.

What does benthic mean? (Living on or in the bottom of a body of water) What kinds of animals might live on or in the bottom? How do we know what organisms live on the bottom? Introduce the term “infauna.” Brainstorm animals that might live in the sediments.

Explain that the students are going to examine “samples” from two benthic areas – one at Bullock’s Reach in Upper Narragansett Bay and one at Fox Island, farther south in the Bay. Students will identify and count the organisms they find. Then they will look at a variety of pieces of information to see if they can make any connections between the organisms they find and the areas in which they live.

Give the students sieves and containers of “sediment” with organisms hidden inside. They should sift through the samples, carefully recording the size of the sample and organisms found on the Benthic Sampling – Narragansett Bay lab sheet. When they can identify an organism, they should record it under the broader category column. Example: If four *Mulinia* are identified, it should be recorded in the Bivalves column as Mulinia – 4.

When students have sifted out all the organisms, or when they have completed as many samples as you would like them to do, they should enter their data in a simple Excel spreadsheet (sample provided).

For each site, students should find the number of organisms and the number of different types of organisms in a given volume of sediment.

When the data have been recorded, ask students what kind of patterns they can see. What might explain any patterns they see?

Provide students with the following and ask them to see if there is any new information in the data sources that might be important.

- Map of sewage plants that drain into Narragansett Bay (File: Sewage Plant Map)
- Water quality data from buoys at Bullock’s Reach, Mount View, Fort Wetherill (“Wetherall”), data for the same period a year earlier at GSO Pier (see On-Line Resources below)
- Sediment profiles from upper and lower bay sites (File: Sediment Profiles)
- Shellfish closure maps (File: Shellfish Closure Map)

Once students have discussed possible factors that may influence benthic communities, ask each student or each group to come up with one further question that they would pursue to learn more.

Notes: This laboratory activity can be done with real sediment samples or as a simulation. To obtain real sediment samples, find accessible locations near shore, such as a salt marsh, bay, or beach. Freshwater sediments can be obtained as well. This is a wet and messy process. A shovel or coffee can scoop can be used to collect the sediments. A half-filled five-gallon bucket is plenty for four classes. Contacting a local university or state environmental management officials can get you samples too, if they have a program that does benthic sampling.

Materials required include, for each group of students:
Sieve or kitchen strainer
Wash bottle or Soda bottle (500 ml works well) with sports cap for squirting
Bucket to sieve into
Gloves (optional)
Field guide that includes local benthic organisms (see Print Resources)

Discussion and examination of physical and chemical data are essentially the same as in the simulation lesson.

Standards Addressed:
National Science Education Standards
Content Standard A *Science as Inquiry*

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard C *Life Science*

- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard G *History and Nature of Science*

- Science as a human endeavor
- Nature of science

AAAS Project 2061 Benchmarks
1B Scientific Inquiry
1C The Scientific Enterprise
5D Interdependence of Life
11A Systems
12A Values and Attitudes
12B Computation and Estimation
12D Communication Skills

Vocabulary
Anoxic – without oxygen
Benthic – referring to the bottom of a body of water
Bivalve – a mollusk with a two-part shell (example: clam)

Hypoxic – characterized by low oxygen
Infauna – organisms that live in benthic sediments
Univalve - a mollusk with a one-part shell (example: snail)

Resources – Files Provided
1. Benthic Organism Photos – includes sample organism sets from Bullock's Reach and Fox Island. (File: Benthic Organism Photos)
2. Benthic lab sheet simulation (if using simulated sediments and photos)
3. Benthic lab sheet (if using actual sediment samples)
4. Excel spreadsheet with student data June 2005. (File: Benthic sampling data 2005)
5. Map of Narragansett Bay showing Bullock and Fox (File: Map –Bullock and Fox)
6. Map of sewage treatment plants in Narragansett Bay (File: Sewage Plant Map)
7. Map of shellfish closure (File: Shellfish Closure Map)

Resources
Web
Excellent overall resource: Discovery of Estuarine Environments
http://omp.gso.uri.edu/doee/doee.htm

Rhode Island/Narragansett Bay maps
http://omp.gso.uri.edu/doee/maps/rimap1.htm
http://geology.com/satellite/rhode-island-satellite-image.shtml
http://www.dem.ri.gov/bart/stations.htm

To see comparisons of water sampling data at an upper bay and lower bay location, visit http://omp.gso.uri.edu/doee/virtual/sensors.htm

To view data from water quality monitoring stations in Narragansett Bay:
- Bullock's Reach http://www.narrabay.com/empact/default.htm
- Locations closer to the mouth of the Bay:
  Narragansett Bay Buoy Data
  http://www.narrbay.org/d_projects/buoy/buoydata.htm

Discovery of Estuarine Environments – Benthic Community
http://omp.gso.uri.edu/doee/science/biology/benth1.htm

Policy and combined sewer overflows
http://omp.gso.uri.edu/doee/policy/orga1.htm

General Bay water quality info
http://www.narrabay.com/empact/default.htm

Narragansett Bay Buoy Data
http://www.narrbay.org/d_projects/buoy/buoydata.htm

Map of Sewage Treatment Plants that Drain Into Narragansett Bay

http://omp.gso.uri.edu/doee/maps/m13.htm

Shellfish closure map
http://www.dem.ri.gov/maps/mapfile/shellnar.jpg

Print Resources

Gosner, K.L. 1978. *A Field Guide to the Atlantic Seashore.* Boston: Houghton Mifflin Company

Massie, F., ed. 1998. *The Uncommon Guide to Common Life of Narragansett Bay*. Providence, Rhode Island: Save The Bay, Inc.

Weiss, H. M. 1995. *Marine Animals of Southern New England and New York.* Identification keys to common nearshore and shallow water macrofauna. State Geological and Natural History Survey of Connecticut, Department of Environmental Protection.