ocean explorer
oceanexplorer.noaa.gov

Hudson Canyon Expedition

Is There Sewage in My Sample?

Focus
Sediment sampling and ocean pollution

Grade Level
5 - 6

Focus Question
How do scientists collect and study the sediments on the bottom of the ocean? Can the sediment sampling methods used by scientists detect pollution?

Learning Objectives
Students will learn about the proximity of the Hudson Shelf Valley and the Hudson Canyon to one of the Nation's most populated areas.

Students will learn that from 1987 to 1992, two dumpsites in the Hudson Shelf Valley and Hudson Canyon, one 12 miles out to sea and one 106 miles out to sea, were used to dispose of sewage.

Students will learn how scientists collect and use core samples to study seafloor sediments.

Students will learn about some of the impacts of dumping sewage in the ocean.

Materials
For the teacher:
- ❒ Overhead map of the Hudson Shelf Valley and Hudson Canyon – attached
  http://woodshole.er.usgs.gov/project-pages/newyork/ or
  http://pubs.usgs.gov/factsheet/fs114-99/fs114-99.html
- ❒ Three egg cartons (cardboard or Styrofoam)
- ❒ Scissors
- ❒ Four medium-sized containers of Playdough (four different colors)
- ❒ Optional: rolling pin
- ❒ Knife
- ❒ Sand
- ❒ Permanent Magic Marker

Per six students:
- ❒ One half of an egg carton (cardboard or Styrofoam) OR one ice cube tray
- ❒ Six straws
- ❒ One permanent magic marker
- ❒ Four colored pencils or four crayons that match the four colors of Playdough used

Audio/Visual Equipment
Overhead projector

Teaching Time
One hour

Seating Arrangement
In groups of six

Maximum Number of Students
36

Kew Words
Core sample
Grid
Sediment
Sewage

Background Information

During scientific expeditions, scientists often collect the upper 10-70 cm of sediment using submersible or ship-deployed corers and analyzing the sediment samples for contaminants. Corers are like giant, strong straws that scientists can push down into the seafloor to take a sediment sample. During the Hudson Canyon Cruise, scientists want to know how much the concentrations of contaminants from sewage have changed since the sewage dumping ceased and if the contaminants are being dispersed into other areas of the ocean by currents.

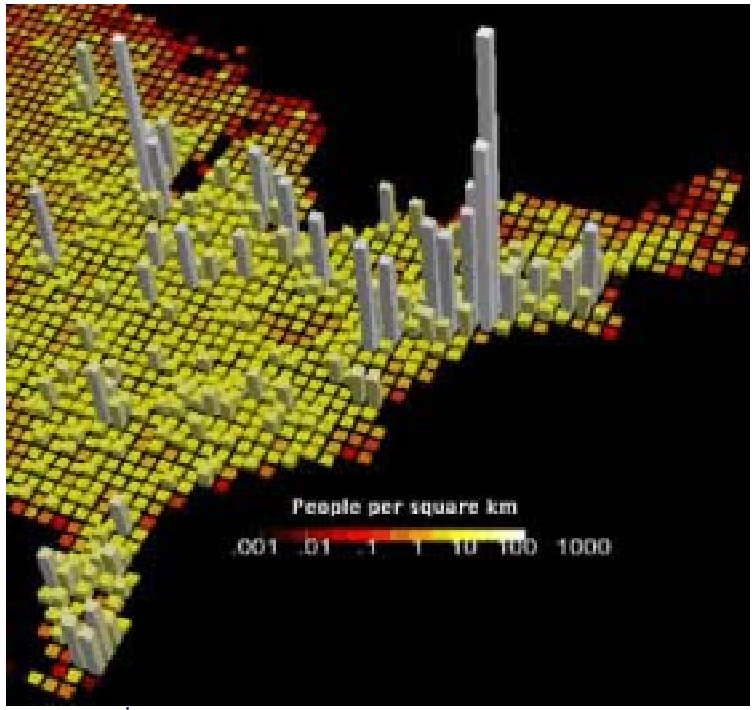

Figure 1. Population density of the eastern United States. Polluted sediments occur in the coastal ocean near major population centers. Fifty percent of the U.S. population lives within 50 miles of the coasts; about 80% within 200 miles. The New York-New Jersey region is one of the largest population centers.

Scientists can collect sediment samples using gravity cores or box cores. Both are devices that can extract a sediment sample into a long tube (much like the straws students will be using in this lesson). The long samples of sediments contained in the tubes are called cores. The cores can be brought to the ocean surface and studied extensively in laboratories. To see a representative sample taken by a box core, please visit the website listed below. http://www.whoi.edu/science/GG/corelab/hardware/systems_ boxcore.html

The following background information has been taken, with permission, from the following USGS publication: *Contaminants and Marine Geology in the New York Bight: Modern Sediment Dynamics and a Legacy for the Future*. This document was written by Ellen L. Mecray, Marilyn Buchholtz ten Brink, and Bradford Butman of the U.S. Geological Survey at Woods Hole Field Center. This publication is available at the following website address: http://marine.usgs.gov/

The Impact of Human Activity in the New York Bight

The New York-New Jersey metropolitan area is one of the most populated and polluted coastal regions in the United States (fig. 1). The area offshore of New York is used for waste disposal, transportation, recreation, and commercial and recreational fishing. The largest deposit of sewage sludge in the country has been dumped in the apex of the New York Bight (125 million cubic meters over 64 years) (fig. 2). Harbor dredge spoils that are contaminated with heavy metals and organic pollutants also have been disposed of in the area, while additional wastes are carried directly from land by regional currents. Materials from diverse sources have added large amounts of metals, carbon, bacteria, and organic contaminants to the sea floor over the last century. These materials have been dispersed and diluted over time; however, sediments have become polluted as a result of these activities. Enforcement of environmental legislation and reduced use of the oceans for waste disposal have resulted in fewer sources of pollutants to coastal sediments in recent years.

The U.S. Geological Survey's Coastal and Marine Geology Program is conducting a long-term mul-

Figure 2. Bathymetry of the coastal ocean in the New York-New Jersey metropolitan region. The sandy, relatively shallow mid-Atlantic continental shelf is bisected by the Hudson Shelf valley, a submerged river valley containing muddy sediments that may act as a conduit for cross-shelf transfer of sediments.

tidisciplinary study in the New York-New Jersey region to characterize the sediments on the sea floor, map the distribution of contaminants in the sediments, and develop a predictive model for the long-term transport and fate of sediments and contaminants. This regional understanding of the sea-floor geology and dynamics of these coastal sediments is needed by Federal, State, and local agencies for management and use of the coastal ocean, and by scientists to plan and conduct research and monitoring.

Mapping the Sea-floor and Its Contaminants

Mapping of the sea-floor geology in the New York-New Jersey metropolitan region provides an overall synthesis of the sea-floor environment, including sediment texture, topography, and the effects of human activity. Data collected from each survey consist of sidescan sonar mosaics, high-resolution seismic profiles, sediment samples, and bottom photography. The resulting maps of the sea floor show changes in the bottom character and sediment texture and the effects of human activity.

The distribution of contaminants in sediments and changes in their patterns observed over time have been used to identify dispersal and deposition patterns, transport rates, and to ascertain the potential of the affected sediments for inducing toxic effects in biota. Chemical and physical analyses of sediment samples were combined with seismic data to provide a three-dimensional assessment of contaminant distribution in the region. Many contaminants adhere to particles and move with the sediments in the marine environment. The distribution patterns measured for one particle-reactive contaminant are often similar to those of another contaminant that has similar sources. Consequently, areas where lead concentrations are high also have high concentrations and inventories of many other pollutants.

Metal and bacterial contaminants measured in sediment samples indicate widespread pollution on the broad, sandy shelf and in the muddy sediments of the Hudson Shelf valley. The highest concentrations occur in muddy deposits near dump sites and in the northern basins of the upper Hudson Shelf valley. More than 10 percent of the sewage sludge dumped is found in the upper valley. Metal concentrations show that sediment is migrating away from the dump sites as far as 80 km down the valley. These pools of pollutants are an ongoing source of contaminants and carbon to the New York Bight. Monitoring the sediment record over time shows decreasing concentrations of contaminants in sediments near the disposal sites. This decrease is a result of improvements in disposal practices and removal of the finer sediments from the sandy shelf by winnowing. Despite disposal regulations and the cessation of dumping, the data suggest that sediments are continually redistributed by currents and biological processes. Mixing in the sediments allows contaminated material to be accessible to benthic organisms.

Future Work

In order to identify detrimental effects to the ecosystem that are attributable to human activity, the spatial and temporal distribution of contaminants in affected sediments must be established. An understanding of the mobility, transport rates, and paths of sedimentary particles and associated contaminants is also necessary for predicting the fate of substances that people have introduced into the ocean.

Future success in managing a sustainable ecosystem will rely on continued efforts to (1) characterize affected areas, (2) identify physical and biological processes, (3) provide appropriate data syntheses, and (4) involve the public. Pollution in the New York Bight occurs on a much larger scale than near smaller urban centers and studies here can be used to guide studies and regulation elsewhere.

Learning Procedure

Overview:

Prior to the lesson, the teacher will create a layered ocean seafloor using and egg carton (or ice cube tray) and Playdough. Three layers of Playdough will be placed into five wells within the egg carton or ice cube tray. Four layers will be placed in one well of the egg carton or ice cube tray. This additional layer will represent sewage. The egg carton (or ice cube tray) is used to introduce students to the concepts of mapping and using a grid system. All layers will be covered by sand. Students will use straws to take a sample from each location within the grid and to pinpoint the location within the grid that contains the contaminant.

Teacher Prep:

- Cut three egg cartons in half to create six total containers.
- Label each container according to the following diagram using permanent Magic Marker.

	A	B
1		
2		
3		

Note: If using ice cube trays, just label the top six "wells" in the manner shown above.

- Roll out Playdough into flat sheets, about 1/8 of an inch thick. You should create a total of four flat sheets.
- Stack three of the four sheets of Playdough on top of one another.
- Cut the layered sheets into 36 squares (each square will contain three layers of different colored Playdough) roughly the size of one egg container "well," where well refers to the depression in which an egg sits within an egg carton.
- Place one layered Playdough square into each "well" of the egg carton.
- Cut the remaining sheet of Playdough into 6 squares. These will represent polluted sediments.
- Place "polluted sediment" squares into well B-2, on top of the other layers of Playdough.
- Press layers of Playdough snugly down into each well of the egg cartons.
- Place a thin layer of sand, roughly 1/8th inch, over the top of each well. Students should not be able to see the layers of Playdough beneath the top layer of sand.

The Day of the Lesson:

1. Show students the location of the Hudson Shelf Valley and Hudson Canyon relative to the big cities of New York and New Jersey.
2. Tell students about the sewage that was dumped into the ocean from 1987 to 1992.
3. Show students the approximate location of the dumpsites.
4. Tell students how scientists might collect sedi-

ment samples from the ocean seafloor during scientific expeditions.

5. Draw a grid up on the board like the one drawn above.
6. Explain, if needed, how to use a grid system (i.e. A-1, B-2, A-3, etc.) to specify a particular location.
7. Tell students that they are about to receive a "piece" of the ocean seafloor and they have some detective work to do. Explain that they will need to take sediment samples, similar to the way scientists sample the seafloor when taking sediment core samples. Also explain that sewage has been dumped somewhere within their "piece" of the ocean seafloor and that it is up to them to determine the location of the dump site. Tell students the color of the sewage material.
8. Pass out egg cartons and explain again, if needed, how a letter and a number can be used to specify one well in their container.
9. Pass out a straw to each student.
10. Tell students that they will each be responsible for sampling one well within their group's container. Ask students to work together to decide who will sample each well.
11. Ask students to write the location (i.e., A-1) of the sample they will take on one end of their straw using a permanent Magic Marker. Explain why scientists must be sure to label all samples correctly.
12. Tell the group to take turns sampling "their wells" and to show the rest of the group the sample they collected at the end of their turn.
13. To take a sample, ask students to insert the non-labeled end of their straw into a well and to push gently to the bottom of the container. Tell students to gently rotate their straw around in a circle several times and then pull their straw upwards. Students should be able to view a layered sample within their straw! Student groups should collect a total of six samples (A-1, A-2, A-3, B-1, B-2, B-3). Sample B-2 should be the location of the dump site, since this "well" contains the "pollutant."
14. Optional: Ask each group to draw a picture of each of the sediment core samples they collected using colored pencils or crayons and to be sure to correctly label each sample represented.
15. Ask students to identify the sewage dump site.
16. Explain how and why scientists collect sediment samples.
17. Explain how pollutants that are buried beneath other layers of sediment can be reintroduced to the water column over time.
18. Explain that scientists have found that pollutants from the old sewage sites are traveling from the sewage site seaward. Discuss possible implications.

The BRIDGE Connection

Visit the BRIDGE website at http://www.vims.edu/bridge/. Under the Navigation toolbar click on Marine Geology and then Ocean Planet: Sea Secrets to access more activities on ocean pollution.

The "ME" Connection

Along a watershed or river, how can chemical spills that occur upstream impact the people and wildlife living downstream? How might these spills, after they enter the open ocean, ultimately affect your life someday?

Connections to Other Subjects

Geography - Using a map of your state, ask students to provide the general map coordinates (i.e., A-15) for particular cities.

Evaluation

Tell students that a "Know-it -all" from the eighth grade is exclaiming that the contamination site is A-1 not B-2. Ask students to write a brief paragraph explaining how they determined the true location of the contamination site.

Extensions

If you are an ambitious teacher with ambitious students, you could modify this lesson so that each group of six students samples a different region of the seafloor (i.e., group one has samples A-1 through B-3, group two has samples C-1 through D-3, etc.). Once all samples have been collected, the entire class would need to work together to identify contamination sites and to map all of the seafloor regions. You could rig the samples so that students find a trend in the location of pollutants.

Resources

Web site for student research
http://www.mbari.org/

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

Content Standard D: Earth and Space Science

- Structure of the Earth system

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

Acknowledgements

This lesson plan was developed by Stacia Fletcher, South Carolina Aquarium, Charleston, SC for the National Oceanic and Atmospheric Administration. If reproducing this lesson, please cite NOAA as the source, and provide the following URL:
http://oceanexplorer.noaa.gov

Student Handout

Hudson Shelf Valley and Hudson Canyon