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Life on the Edge: Exploring Deep Ocean Habitats

So, What's It Doing Today?

Focus
Short-term variations in sea-surface phenomena of the Gulf Stream

Grade Level
9-12 (Earth Science)

Focus Question
How can we study surface temperature, chlorophyll concentration, and water flow in the ocean without going to sea?

Learning Objectives
Students will be able to use satellite imagery to obtain information on selected oceanographic parameters in the Gulf Stream.

Students will be able to describe short-term variations in selected oceanographic parameters that they have observed in the Gulf Stream.

Students will be able to infer and explain the potential significance of observed oceanographic parameter variations to biological communities.

Materials
❒ Computers with internet access

Audio/Visual Materials
None

Teaching Time
One or two 45-minute class periods, plus time for student internet research

Seating Arrangement
Groups of 4-6 students

Maximum Number of Students
30

Key Words
Continental shelf
Continental slope
Hard bottom
Lophelia pertusa
AVHRR
Chlorophyll
SeaWiFS
Gulf Stream
Gulf Stream rings
Ground truthing

Background Information
For hundreds of years, thousands of fishermen have harvested U.S. coastal waters of the Atlantic Ocean and Gulf of Mexico. Yet, the marine habitats of the adjacent outer continental shelves and slopes are poorly studied and in many cases completely unknown. Until recently, most scientists assumed that these habitats did not support large or productive biological communities. Although no one had actually visited the edges of the continental shelves for a first hand look, they believed that the extensive commercial fisheries depended upon migrations from other areas and/or nutrients carried in from deeper or coastal waters. But once they actually began exploring the area more thoroughly, scientists found many diverse and thriving benthic communities.

Between North Carolina and Florida, several unique habitats are found where the topography of the outer continental shelf is extremely rugged and swept by the powerful currents of the Gulf Stream. Hard or "live" bottom habitats support diverse biological communities that include valuable fish and invertebrate resources. On the edge of the continental shelf where depths range from 80 to 250 m, hard bottom communities provide the foundation for the food web of many commercially important species. But while scientists have studied many hard bottom communities within the range of SCUBA gear, they know very little about about the ecology of these communities in deeper waters.

Even deeper, on the middle of the continental slope, the deep-sea coral *Lophelia pertusa* forms another almost-unexplored habitat. Here, in depths of 400 to 700 m, branches of living coral grow on mounds of dead coral branches that can be several meters deep and hundreds of meters long. Unlike corals that produce reefs in shallower waters, *Lophelia* does not have symbiotic algae and receives nutrition from plankton and particulate material captured by its polyps from the surrounding water. *Lophelia* mounds alter the flow of currents and provide habitats for a variety of filter feeders. Scientists suspect that many other organisms may also inhabit deep-sea coral reefs, including commercially important fishes and crustaceans. But they don't know for sure, because most of the hard bottom and deep-sea coral habitats on the edge and slope of the continental shelf are still unexplored.

The 2003 Life on the Edge Expedition will search previously unexplored hard bottom habitats and deep coral banks on the edge and slope of the continental shelf adjacent to the coasts of North and South Carolina and define the biological communities living in these habitats. Although they are mainly focussed on bottom habitats, scientists also plan to gather data on biological communities at the ocean surface because their previous research has indicated that surface plankton and the alga *Sargassum* serve as primary carbon sources (i.e., they are the primary producers in the food web). Primary production is affected by water temperature and the availability of nutrients. The Gulf Stream is expected to have a major influence on primary production in this area, since water temperature and availability of nutrients are known to affect photosynthetic processes.

The purpose of this activity is to introduce students to some of the tools that are available for studying real-time and near-real-time phenomena in the Earth's oceans.

Learning Procedure

1. Review the general geographic location and form of the continental shelf adjacent to the U.S. Atlantic coast. Tell students that very little is known about the ecology of the edge and slope of the shelf, but that recent explorations have found diverse and thriving benthic communities. Visit http://oceanexplorer.noaa.gov for more background information about the Life on the Edge Expedition.

2. Review the general location and circulation pattern of the Gulf Stream. Ask students to list some ways that the Gulf Stream may affect biological communities on the edge and slope of the continental shelf adjacent to the coasts of North and South Carolina. Be sure students understand the concept of primary production, and the relationship of chlorophyll to this process.

   Briefly introduce the following types of data from remote-sensing tools that can be used by anyone who wants to study the Earth's oceans:

   - **Sea surface temperature** – measured by the Advanced Very High Resolution Radiometer (AVHRR), and also by fixed buoys

- **Chlorophyll Concentration** – based on measurements of sea surface color by the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) satellite (see the "Going for the Green" lesson for additional discussion)

- **Current velocity** – based on data from the near-real-time radar altimeter of the European Environmental satellite

Visit http://fermi.jhuapl.edu/student/phillips/satellites.htm for additional discussion of remote sensing tools for oceanography and examples applied to the Gulf Stream.

3. Tell students that their assignment is to prepare a written report that describes variations in the Gulf Stream over the past two weeks, including overall circulation, surface temperature, chlorophyll concentration, and major eddies or rings (you may want to review the "Ring Detectives" lesson for more discussion about Gulf Stream rings). Appropriate images should also be provided to accompany these descriptions. Reports should also include inferences about the potential significance of observed activity to biological communities.

   Direct students to the following websites for data and resources:

   http://fermi.jhuapl.edu/avhrr/ – John Hopkins University Applied Physics Laboratory

   http://marine.rutgers.edu/mrs/ – Rutgers University Institute of Marine & Coastal Sciences

   http://www.ndbc.noaa.gov/Maps/Southeast.shtml – NOAA's National Data Buoy Center; click on a buoy to access sea surface temperature and other oceanographic data

   http://dutlru8.lr.tudelft.nl/altim/gulfstream/ – Estimated current velocities, provided by the Delft Institute for Earth-Oriented Space Research

   http://seawifs.gsfc.nasa.gov/cgi/seawifs_browse.pl – The SeaWiFS browser page (see the "Going for the Green" lesson for detailed instructions)

   You may also want to download (or have your students download) a copy of NIH Image, a public domain image processing and analysis program that can acquire, display, edit, enhance, analyze and animate images. NIH Image is written for Macintosh platforms, but a free PC version is available from Scion Corporation and a Java program called Image/J will "run anywhere." Visit http://rsb.info.nih.gov/nih-image/download.html for more information. Visit http://octopus.gma.org/surfing/summary.html for some ideas about how to use satellite imagery with NIH Image.

4. Have student groups make oral presentations of their research results. Discuss the importance of "ground truthing" remotely sensed data, and the limitations of these data. Interpretation of satellite imagery always depends upon direct observation of the phenomena being studied, and periodic checks to validate the assumed relationships between the imagery and the phenomena being studied. Moreover, while we can make inferences about how observed phenomena may affect biological communities, it is critical to actually visit these communities to confirm (or disprove) these inferences. While our knowledge of ocean systems is constantly improving, our understanding of these systems is still imperfect and incomplete, which is one of the reasons that ocean exploration is so exciting!

The BRIDGE Connection

www.vims.edu/BRIDGE/ – Click on "Ocean Science" in the navigation menu to the left, then "Physics," then "Currents" for resources on the Gulf Stream.

The "Me" Connection

Have students write a short essay on how knowledge of oceanographic conditions on the sea sur-

face could be of practical benefit to people other than scientists.

Connections to Other Subjects

English/Language Arts, Physical Science, Life Science

Evaluation

Written reports prepared in Step 3 and oral reports in Step 4 provide opportunities for assessment.

Extensions

Log on to http://oceanexplorer.noaa.gov to keep up to date with the latest discoveries by the Life on the Edge Expedition, and to find out what researchers are learning about deep-water hard-bottom communities.

Visit http://www.k12science.org/curriculum/gulfstream/ for more activities on the Gulf Stream.

Visit http://octopus.gma.org/surfing/summary.html, and http://www.imcs.rutgers.edu/mrs/education/education.htm for more activities using satellite imagery

Visit http://seawifs.gsfc.nasa.gov/SEAWIFS.html for more background and activities related to the SeaWiFS project.

Resources

http://www.k12science.org/curriculum/gulfstream/ – The Gulf Stream Voyage website developed and managed by the Center for Improved Engineering and Science Education (CIESE) at Stevens Institute of Technology in Hoboken, New Jersey

http://fermi.jhuapl.edu/student/phillips/ – Background information on the Gulf Stream

http://fermi.jhuapl.edu/avhrr/ – John Hopkins University Applied Physics Laboratory

http://octopus.gma.org/surfing/summary.html – Activities using satellite imagery

http://www.imcs.rutgers.edu/mrs/education/education.htm – Rutgers Coastal Ocean Observation Lab with classroom activities

http://www.ndbc.noaa.gov/Maps/Southeast.shtml – NOAA's National Data Buoy Center

Visit http://seawifs.gsfc.nasa.gov/SEAWIFS.html for more background and activities.

http://dutlru8.lr.tudelft.nl/altim/gulfstream/ – Website of the Delft Institute for Earth-Oriented Space Research

http://oceanica.cofc.edu/activities.htm – Project Oceanica website, with a variety of resources on ocean exploration topics

http://pubs.usgs.gov/of/of01-154/index.htm – U.S. Geological Survey Open-File Report 01-154 "Sea-Floor Photography from the Continental Margin Program"

National Science Education Standards

Content Standard A: Science as Inquiry

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

Content Standard B: Physical Science

- Motions and forces

Content Standard C: Life Science

- Interdependence of organisms

Content Standard D: Earth and Space Science

- Energy in the Earth system

Content Standard E: Science and Technology

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Natural resources
- Environmental quality
- Natural and human-induced hazards

For More Information

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Acknowledgements

This lesson plan was produced by Mel Goodwin, PhD, The Harmony Project, Charleston, SC for the National Oceanic and Atmospheric Administration.