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2006 Olympic Coast Deep Corals Expedition

Treasures in Jeopardy

(adapted from the Florida Coast Deep Corals 2005 Expedition)

Focus
Conservation of deep-sea coral reefs

Grade Level
7-8 (Life Science)

Focus Question
How can deep-sea coral reefs be protected from damage by human activities?

Learning Objectives
Students will be able to compare and contrast deep-sea coral reefs with their shallow water counterparts.

Students will be able to explain at least three benefits associated with deep-sea coral reefs.

Students will be able to describe human activities that threaten deep-sea coral reefs.

Students will be able to describe actions that should be taken to protect deep-sea coral reef resources.

Materials
❒ Access to the internet, or copies of materials cited in "Learning Procedure"

Audio/Visual Materials
❒ None

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

Seating Arrangement
Groups of two to four students

Maximum Number of Students
30

Key Words
Deep-sea coral
Conservation
Pharmaceuticals
Lophelia
Oculina

Background Information
For hundreds of years, fishermen have harvested coastal waters of the Pacific Northwest. Yet, the deepwater habitats that support these fisheries are poorly studied and in many cases completely unknown. On deeper portions of the continental shelves, hard or "live" bottom habitats support diverse biological communities that provide the foundation for the food web of many commercially-important species. Deep-water corals, particularly corals belonging to the genus *Lophelia*, form reefs that may have a diversity of species comparable to that of corals reefs in shallow waters. Often, sponges and soft corals are important parts of these reefs as well. But although shallow coral reefs have been studied extensively, scientists know very little about about the ecology of coral communities in depths beyond the range of SCUBA gear.

The Olympic Coast National Marine Sanctuary (OCNMS) is an area of 3,310 square miles off

of Washington State's Olympic Peninsula, as well as 135 miles of shoreline that includes some of the last remaining wilderness coastline in the lower 48 states. The seaward boundary of the Sanctuary extents 40 miles offshore to depths of 1,400 m, and encompasses most of the continental shelf, as well as a variety of marine habitats including kelp beds, subtidal reefs, rocky and sandy intertidal zones, submarine canyons and plankton-rich upwelling zones. Acoustic surveys between 2001 and 2004 revealed deep, hard-bottom areas that scientists believe may include extensive coral and sponge communities. These habitats are part of one of the most productive marine ecosystems in North America, and support many commercial fisheries, including halibut, hake, salmon, and rockfish. The overall mission of the OCNMS was to protect the Olympic Coast's natural and cultural resources by conserving its resources as well as encouraging uses that are compatible with conservation.

A growing concern among managers of the OCNMS is the impact of bottom-fishing on deep-water coral and sponge habitats. Species that form deep-water habitats typically have long life-spans, slow growth rates, and fragile structures that make them particularly vulnerable and slow to recover from physical damage. Many investigations have reported large-scale damage to deepwater reefs caused by commercial fishing trawlers. There is also concern about damage that might result from other activities such as exploration and extraction of fossil fuels, and trenching for installation of submarine cables. Because the mission of the OCNMS is to protect the Olympic Coast's resources for the use and enjoyment of future generations, there is an urgent need to locate deep-sea coral and sponge communities so appropriate protective actions can be taken.

The central objective of the Olympic Coast Deep Corals Expedition was to document the location and condition of deep-sea coral and sponge communities in the Olympic Coast National Marine Sanctuary. The Expedition used an underwater robot called ROPOS (Remotely Operated Platform for Ocean Science) owned by the Canadian Scientific Submersible Facility to obtain video and photographic documentation of deep-sea coral and sponge communities, as well as to collect biological samples from these communities for species identification. Specific objectives of the Expedition included:

- Locating and mapping deep-sea coral and sponge communities in the Sanctuary;
- Characterizing diversity, abundance, and health of living marine resources associated with these communities; and
- Documenting the impact of fishing activities on these communities.

One of the problems confronting efforts to conserve deep-water reef systems is that it is difficult to build public empathy for these systems because most people will never see them. Consequently, a key part of efforts to protect deep-sea coral reefs involves educating the public about these valuable resources. In this lesson, students will develop materials that can be used as part of this kind of education activity.

Learning Procedure

1. To prepare for this lesson, read the introductory essays for the Olympic Coast Deep Corals Expedition at http://oceanexplorer.noaa.gov/explorations/06olympic.

2. If your students are not familiar with the Cnidaria, briefly review the basic biology and classification of this phylum (for an easy introduction, check out http://www.ucmp.berkeley.edu/cnidaria/cnidaria.html; for a suggested list of points to be reviewed, see the "Deep Gardens" lesson). You may also want to view and possibly download the video of deep-sea corals from http://oceanexplorer.noaa.gov/explorations/02alaska/logs/summary/media/movies/deepseacoral_video.html.

Briefly review deep-water coral reefs, and contrast these reefs with the more familiar shallow-water reefs. Tell students that deep-water reefs are important in a variety of ways, but are significantly jeopardized by human activity (keep the discussion very general at this point, since students will be researching details as part of their assignment). Say that because of their location, deep-water reefs and their associated benefits and problems are largely unknown to the general public. Consequently, there is an urgent need for public education as a first step toward protecting these valuable resources.

3. Tell students that their assignment is to develop a poster that could be used as part of efforts to educate the general public about the importance of deep-water coral reefs and the need to protect them. Each poster should address the following questions (students may want to use these questions as headings on their poster):
   - What are deep-water coral reefs?
   - Where are they found?
   - How are deep-water coral reefs different from coral reefs in shallow water?
   - Why are deep-water coral reefs important?
   - What is the problem?
   - What needs to be done?

   Encourage students to use images of deep-water corals and coral reefs as part of their poster.

   You may want to direct students to the July 2005 issue of *Current: The Journal of Marine Education* which is a special issue on deep-sea corals (available online at http://www.mcbi.org/what/current.htm), or allow them to discover this (and other resources) on their own.

4. Lead a group discussion of students' posters. Each poster should include the following points:
   - Deep-water coral habitats occur at depths of 70 to greater than 1000 m.
   - Deep-sea corals are known from all the world's ocean.
   - Deep-water corals often lack symbiotic algae (zooxanthellae) that are typical of shallow-water corals.
   - Typical deep-water corals include *Lophelia pertusa*, *Oculina varicosa*, hydrocorals (family Stylasteridae), black corals (order Antipatharia), bamboo corals (family Isididae), and sea fans (order Gorgonacea). [Note that images of all these are readily available on the internet.]
   - *Oculina* and *Lophelia* dominate deep reefs off the southeastern coast of the United States.
   - Coral is an important habitat-provider on *Oculina* and *Lophelia* reefs.
   - *Lophelia* reef systems in the northeast Atlantic include more than 1,300 species of fish and invertebrates.
   - Only a small percentage of deepwater reefs have been mapped or have had their biological resources characterized.
   - Very little is known about deep-sea coral distribution, population dynamics, ecology, or about how these corals function in providing habitat for other species.
   - Many new species of deep-sea corals have been discovered on seamounts.
   - Many seamount species are endemic (they do not occur anywhere else) and are therefore exceptionally vulnerable to extinction.
   - Deep-sea sponges and corals are sources of new pharmaceuticals that can be extremely valuable in treating human diseases.

Examples include:
- Discodermolide: isolated from the sponge *Discodermia dissolute*; may treat cancers which are resistant to other drugs
- E7389: isolated from the sponge *Lissodendoryx* sp.; in clinical trials for the treatment of lung cancer and other cancers
- Dictyostatin-1: isolated from a sponge from the order Lithistida; may be more effective than Taxol as an anti-cancer drug
- Topsentin: isolated from the sponge *Spongosporites ruetzleri*, shows promise as an anti-inflammatory agent to treat arthritis and skin irritations, as well as for the treatment of Alzheimer's disease and to prevent colon cancer
- Bone Grafts: shallow tropical corals have been used as bone grafts for more than 10 years, but deep-sea species have not been used though recent research shows that bamboo corals (family Isididae) have a skeletal structure and dimensions that are almost identical to bone
- Collagen: Gorgonin, found in bamboo corals, closely resembles collagen, an important component of bone that also can be used for controlled release of medicines, and as a foundation for tissue rebuilding

- Deep-sea corals usually inhabit places where natural disturbance is rare.

- Many deep-sea corals are slow-growing and may require decades or even centuries to regenerate if they are damaged; but it really isn't known whether these species are capable of repopulating a given area at all if they are destroyed.

- Deep reefs worldwide are being impacted by destructive fishing methods, such as trawling, which destroys the delicate corals.

- Damage from bottom trawling is a global threat to deep-water coral reefs.

- In addition to bottom-trawl fishing, oil and gas production, cable laying, mining, and coral harvest may also negatively impact deep-water coral reefs.

- Protecting the benefit offered by deep-sea coral reefs depends upon measures like the Deep Sea Coral Protection Act (DSCPA) which was introduced in the U.S. House and Senate in 2003-2004. Provisions of the Act include:
  - Freezing the footprint of bottom trawls in all fishery management regions;
  - Preventing trawling from expanding into previously untrawled regions until deep-sea corals in those regions are surveyed and mapped; and
  - Implementing a comprehensive research plan to collect information on deep-sea coral locations and life history.

5. Brainstorm ways that information included in students' posters could be communicated to larger audiences. If possible, display some of the posters at events where they might be seen by other students, parents, and members of the general public.

The Bridge Connection

http://www.vims.edu/bridge/ – In the "Site Navigation" menu on the left, click on "Ocean Science Topics," then "Biology," then "Invertebrates," then "Other Inverts" for links to more information about Cnidaria

The "Me" Connection

Have students write an "op-ed" style essay in which they explain why deep-water coral reefs are personally important and what steps individuals can take to help ensure their protection.

Connections to Other Subjects

English/Language Arts, Earth Science

Assessment

Posters and group discussions provide opportunities for assessment.

Extensions

1. Have students visit http://oceanexplorer.noaa.gov/explorations/06olympic to explore the discoveries made during the Olympic Coast Deep Corals Expedition.

2. Visit the Marine Conservation Biology Institute Web site (http://www.mcbi.org) for more information about deepsea corals and strategies for their protection.

3. Visit http://oceanservice.noaa.gov/education/kits/corals/supp_coral_lessons.html for more activities on coral reefs and how they may be protected.

Resources

http://oceanexplorer.noaa.gov/explorations – Web site for NOAA's Ocean Exploration Program

Pickrell, J. 2004. Trawlers Destroying Deep-Sea Reefs, Scientists Say. *National Geographic News*. http://news.nationalgeographic.com/news/2004/02/0219_040219_seacorals.html

http://www.mcbi.org/what/current.htm – A special issue of *Current: the Journal of Marine Education* on deep-sea corals.

Morgan, L. E. 2005. What are deep-sea corals? Current 21(4):2-4; available online at http://www.mcbi.org/what/what_pdfs/Current_Magazine/What_are_DSC.pdf

Frame, C. and H. Gillelan. 2005. Threats to deep-sea corals and their conservation in U.S. waters. *Current* 21(4):46-47; available online at http://www.mcbi.org/what/what_pdfs/Current_Magazine/Threats_Conservation.pdf

Roberts, S. and M. Hirshfield. Deep Sea Corals: Out of sight but no longer out of mind. http://www.oceana.org/fileadmin/oceana/uploads/reports/oceana_coral_report_final.pdf — Background on deep-water coral reefs

http://oceanexplorer.noaa.gov/gallery/livingocean/livingocean_coral.html – Ocean Explorer photograph gallery

http://oceanexplorer.noaa.gov/explorations/02alaska/logs/summary/media/movies/deepseacoral_video.html – Online video of deep-sea corals from the Ocean Explorer 2002 Gulf of Alaska Expedition

http://olympiccoast.noaa.gov/ – Web site for the Olympic Coast National Marine Sanctuary

http://www.nccos.noaa.gov/ – Web site for the NOAA's National Centers for Coastal Ocean Science, which conduct and support research, monitoring, assessments, and technical assistance for coastal stewardship and management; and participated in the Olympic Coast Deep Corals Expedition

http://www.nurp.noaa.gov/ – Web site for the National Undersea Research Program, which provides scientists with the tools and expertise for investigations in the undersea environment, including submersibles, remotely operated vehicles, autonomous underwater vehicles, mixed gas diving gear, underwater laboratories and observatories, and other cutting-edge technologies

http://www.nwfsc.noaa.gov/ – Web site for the Northwest Fisheries Science Center, which studies living marine resources and their habitats in the Northeast Pacific Ocean and in freshwater rivers and streams in Washington, Oregon, Idaho, and Montana.

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

- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments
- Science and technology in society

Content Standard G: History and Nature of Science

- Nature of science

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 1.
The Earth has one big ocean with many features.

- Fundamental Concept h. Although the ocean is large, it is finite and resources are limited.

Essential Principle 5.
The ocean supports a great diversity of life and ecosystems.

- *Fundamental Concept d.* Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.
- *Fundamental Concept e.* The ocean is three-dimensional, offering vast living space and diverse habitats from the surface through the water column to the seafloor. Most of the living space on Earth is in the ocean.

Essential Principle 6.
The ocean and humans are inextricably interconnected.

- *Fundamental Concept b.* From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.
- *Fundamental Concept c.* The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.
- *Fundamental Concept e.* Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
- *Fundamental Concept g.* Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Essential Principle 7.
The ocean is largely unexplored.

- *Fundamental Concept a.* The ocean is the last and largest unexplored place on Earth—less than 5% of it has been explored. This is the great frontier for the next generation's explorers and researchers, where they will find great opportunities for inquiry and investigation.
- *Fundamental Concept c.* Over the last 40 years, use of ocean resources has increased significantly, therefore the future sustainability of ocean resources depends on our understanding of those resources and their potential and limitations.
- *Fundamental Concept d.* New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
- *Fundamental Concept f.* Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

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