



2004 Gulf of Alaska Expedition

Forests of the Deep

FOCUS

Deep-sea coral communities associated with seamounts

GRADE LEVEL

5-6 (Life Science)

FOCUS QUESTION

Why are scientists concerned about the future of deep-sea coral communities associated with seamounts?

LEARNING OBJECTIVES

Students will be able to explain at least three ways in which seamounts are important to biological communities.

Students will be able to infer at least three ways in which deep-sea corals are important to seamount ecosystems.

Students will be able to explain why many scientists are concerned about the future of seamount ecosystems.

MATERIALS

- (Optional) Images of seamounts and deep-sea corals (see Learning Procedure)

AUDIO/VISUAL MATERIALS

- (Optional) Copies of images of seamounts and deep-sea corals

TEACHING TIME

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

SEATING ARRANGEMENT

Cassroom style or groups of 3-4 students

MAXIMUM NUMBER OF STUDENTS

30

KEY WORDS

Endemic
Seamount
Deep-sea coral
Bottom trawling

BACKGROUND INFORMATION

Seamounts (also called "guyots") are undersea mountains that are generally thought to be the remains of underwater volcanoes, often with heights of 3,000 m (10,000 ft) or more. There are an estimated 30,000 seamounts in all of the Earth's ocean, but only a few hundred have been visited by explorers, and far fewer have been intensively studied. Volcanoes that can form seamounts are often associated with the movement of the tectonic plates that make up the Earth's crust. Where these plates move apart (for example, along the mid-ocean ridge in the middle of the Atlantic Ocean) a rift is formed, which allows magma (molten rock) to escape from deep within the Earth and harden into solid rock known as basalt. Where tectonic plates come together, one plate may descend beneath the other in a process called subduction, which generates high temperatures and pressures that can lead to explosive volcanic eruptions (such as the Mount St. Helens eruption which resulted from subduction of the Juan de Fuca tectonic plate beneath the North American tectonic plate). Volcanoes can

also be formed at hotspots, which are thought to be natural pipelines to reservoirs of magma in the upper portion of the Earth's mantle.

In the late 1960's, biologists searching for new commercial fishing grounds discovered that seamounts have high biological productivity compared to surrounding ocean waters, and provide habitats for a variety of plant, animal, and microbial species, many of which were previously unknown. Deep-sea corals are often conspicuous, and provide essential habitat for other organisms in seamount ecosystems. Seamounts and plateaus near Australia and New Zealand were found to have large populations of deep water fish with firm, tasty flesh. One species, the orange roughy (*Hoplostethus atlanticus*), is now common in North American markets. But fish stocks on seamounts were quickly diminished by commercial fishing vessels. Some studies report that deep-water trawlers have reduced orange roughy populations by as much as 90%. In addition, bottom trawling severely damages entire bottom communities: trawling is known to have removed 85% of the living cover from some seamounts (Malakoff, 2003). In February 2004, concern for this large-scale destruction of virtually unexplored ecosystems led 1,136 scientists from 69 countries to release a statement calling for governments and the United Nations to protect deep-sea coral and sponge ecosystems.

This same concern has stimulated scientific research on seamounts. The few existing surveys of seamounts suggest that many seamount species are endemic (found on only one or a few adjacent peaks). Recent research has shown that obscure, bottom-dwelling species may contain powerful drugs that directly benefit humans. On some seamounts, up to half the fishes and invertebrates are estimated to be unique. Seamounts may serve as "stepping stones" that allow other species to expand their ranges, and may also help individuals of some species migrate over long distances by providing "rest stops" or navigational reference points.

Numerous seamounts have been discovered in the Gulf of Alaska, many of which occur in long chains that parallel the west coast of the U.S. and Canada. In 2001 and 2002, Ocean Exploration expeditions studied the long Axial-Cobb-Eikelberg-Patton chain. The Ocean Exploration 2004 Gulf of Alaska Expedition will investigate the northernmost chain that stretches roughly 900 km from Kodiak Seamount at the Alaskan Trench to Bowie Seamount off of the Queen Charlotte Islands. Particular attention is being directed toward deep-sea coral communities associated with these seamounts.

In this activity, students will research conservation issues associated with seamounts, develop inferences about the importance of seamount ecosystems and the contribution of deep-sea corals to these ecosystems.

LEARNING PROCEDURE

1. Explain that seamounts are the remains of underwater volcanoes, and that they are islands of productivity compared to the surrounding environment. Tell students that expeditions to seamounts often report many species that are new to science and many that appear to be endemic to a particular group of seamounts.

You may want to show images of deep-sea corals and seamount communities from http://oceanexplorer.noaa.gov/gallery/livingocean/livingocean_coral.html or http://www.mcbi.org/DSC_statement/coral_images.htm, or direct students to these sites. Point out deep-sea corals, and tell students that these animals are an important part of seamount ecosystems.

2. Tell students (or student groups) that their assignment is to write a brief report containing:
 - (a) A description of at least three ways in which seamounts are important; and
 - (b) At least three inferences about how deep-sea corals are important to biological communities on seamounts.

Some Web sites that may be useful for students' research are listed under "Resources."

3. Lead a discussion of students' research results. The following points should emerge during this discussion:
- Widely distributed ecosystems such as seamounts may be critically important to other systems and species in ways that we do not yet understand.
 - Similarly, species that are as yet undiscovered may also be important to other ecosystems and species (including our own species).
 - Seemingly unimpressive bottom-dwelling organisms (such as soft corals and sponges) have been found to contain chemicals that can act as powerful drugs against human diseases including cancer.
 - Seamounts may serve as "stepping stones," allowing some species to extend their geographic range.
 - Seamounts may provide "rest stops" or navigational reference points for migratory species.
 - Deep-sea corals often form "trees" as tall as 10 feet or more. Like terrestrial trees, these coral colonies can provide shelter for many other species, as well as amplify the available surface area upon which other organisms may grow.
 - Branched corals also modify ocean currents flowing over seamounts. These currents are often fairly strong, but the branched structure of the corals reduces the flow, which in turn causes suspended particles to settle and become available to organisms sheltering beneath the coral branches. If a stream table is available, you can illustrate this by sticking about 20 dowels (ca. 6 mm diameter) into a slab of modeling clay so the dowels are about 1 cm apart. With water flowing through the stream table, add a few drops of food coloring or ink to visualize the flow. Then place the clay block with dowels into the stream, and add a few more drops into the flow upstream of the block. Students should see the coloring slow

and eddy around the dowels, simulating the motion of water around branched corals.

- Seamounts and other deep-sea communities are severely damaged by deep-water bottom trawls that deplete populations of target species and simultaneously destroy their habitat; this double impact makes it highly unlikely that populations of target species can recover.
- The seamount/deep-sea coral conservation issue is typical of many other conservation issue in that short-term objectives (immediate increases to fisheries harvests) conflict with sustainable use of natural resources and maintaining biodiversity. Since both fishing industries and governments are already well-aware of the facts, protection of these resources depends upon public understanding. The situation is analogous in some ways to management of terrestrial forests. Clear-cutting (the terrestrial equivalent of trawling through ocean bottom communities) is generally accepted to be less desirable than a more managed approach to harvesting trees.

THE BRIDGE CONNECTION

www.vims.edu/bridge/ – Click on "Ocean Science" in the navigation menu to the left, then "Ecology," then "Coral" for resources on corals and coral reefs.

THE "ME" CONNECTION

Have students write a short essay on how their own habitats are affected by other organisms.

CONNECTIONS TO OTHER SUBJECTS

English/Language Arts, Mathematics, Earth Science

EVALUATION

Written reports prepared in Step 2 provide opportunities for assessment.

EXTENSIONS

Have students visit <http://oceanexplorer.noaa.gov> to find out more about the 2004 Gulf of Alaska Expedition and about opportunities for real-time interaction with scientists on current Ocean Exploration expeditions.

RESOURCES

http://www.terrature.org/deepsea_coral.htm – Article about scientists' call for protection of deep-sea coral ecosystems

http://www.terrature.org/trawlingScientists_ban.htm – Text of Scientists' Statement on Protecting the World's Deep-sea Coral and Sponge Ecosystems

Malakoff, D. 2003. Deep-sea mountaineering. *Science* 301:1034-1037. – Article on seamounts and deep-sea coral communities

http://www.mcbi.org/DSC_statement/coral_images.htm – Images on the Marine Conservation Biology Institute's Web page

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

<http://oceanica.cofc.edu/activities.htm> – Project Oceanica Web site, 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"

Roberts, S. and M. Hirshfield. Deep Sea Corals: Out of sight but no longer out of mind. http://www.oceana.org/uploads/oceana_coral_report.pdf

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 D: Earth and Space Science

- Structure of the Earth system

Content Standard F: Science in Personal and Social Perspectives

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

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 produced by Mel Goodwin, PhD, The Harmony Project, 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>