

ACTIVITY: LEAVING HOME

FOCUS

Dispersal of benthic invertebrate larvae

GRADE LEVEL

5-6 (Life Science)

FOCUS QUESTION

How can scientists study dispersal mechanisms of invertebrate larvae in the marine environment, and what is the importance of these mechanisms to benthic invertebrate populations?

LEARNING OBJECTIVES

Students will be able to explain the meaning of “larval dispersal” and “larval retention.”

Students will be able to explain the importance of larval dispersal and larval retention to populations of organisms in the marine environment.

Given data on recruitment of organisms to artificial substrates, students will be able to draw inferences about larval dispersal in these species.

MATERIALS

- Copies of “Recruitment to Artificial Substrates Near Bear Seamount,” one copy for each student or student group (see pages 16-17 for a copy)

AUDIO/VISUAL MATERIALS

None

TEACHING TIME

One 45-minute class period

SEATING ARRANGEMENT

Classroom style or groups of 3-4 students

MAXIMUM NUMBER OF STUDENTS

30

KEY WORDS

Seamount	Larval dispersal
New England Seamounts	Larval retention
Endemic	Recruitment

BACKGROUND INFORMATION

Seamounts are undersea mountains that rise from the ocean floor, often with heights of 3,000 m (10,000 ft) or more. Compared to the surrounding ocean waters, seamounts have

high biological productivity, and provide habitats for a variety of plant, animal, and microbial species. Seamounts are formed by volcanic processes, either as isolated peaks or as chains that may be thousands of miles long. In the Atlantic Ocean, the New England Seamounts form a chain of more than 30 peaks that begins on the southern side of George’s Bank near the coast of New England and extends 1,600 km to the southeast. Some of the peaks are more than 4,000 m above the deep-sea floor—similar to the heights of major peaks in the Alps.

While several of the New England Seamounts were visited by geologists in 1974, until recently there has been little biological exploration of these habitats. Preliminary investigations in 2002 found numerous invertebrates, including cephalopods, crustaceans, and more than a hundred other species in 10 different phyla. These investigations also found more than 100 species of fishes, some of which are commercially important. Several species were previously unknown to science. In the summer of 2003, a team of scientists, educators, artists, and oceanographers participated in a cruise on the R/V *Atlantis* to explore some of these seamounts. The submersible *Alvin* was used to visit areas whose depths ranged from 1,100 m to 2,200 m. Photographic images as well as samples of living organisms were collected.

Biological communities in the vicinity of seamounts are important for several reasons. High biological productivity has been documented in seamount communities, and these communities are directly associated with important commercial fisheries. Unfortunately, some of these fisheries cause severe damage to seamount habitats through the use of commercial fishing trawls. Scientists at the First International Symposium on Deep-Sea Corals (August, 2000) warned that more than half of the world’s deep-sea coral reefs have been destroyed. Ironically, some scientists believe that destruction of deep-sea corals by bottom trawlers is responsible for the decline of major fisheries such as cod. Besides their importance to commercial fisheries, seamount communities are likely to contain significant numbers of species that may provide drugs that can directly benefit human beings (see Maxwell, this issue, for more).

Because seamounts are relatively isolated from each other, they can vary greatly in their biodiversity (the number of different species present) and may also have a high degree of endemism (species endemic to seamounts are species that are only found around seamounts). Biodiversity and endemism are both affected by the reproductive strategy used by benthic seamount species. Most benthic marine invertebrates produce free-swimming or floating planktonic larvae that can be carried for many miles by ocean currents until the larvae settle to the bottom and change (metamorphose) into juvenile animals that usually resemble adults of the species. The advantage

of a longer larval phase is it allows for greater dispersal, which gives the species a wider geographic range. On the other hand, although species with shorter larval stages do not have the advantage of broad dispersal, they are more likely to remain in favorable local environments. Some species do not have a free larval stage at all, but brood their larvae inside the adult animal or in egg cases until metamorphosis.

Other forces may also tend to keep larvae from drifting away. Eddies known as Taylor columns can effectively trap larvae that would otherwise be carried away [see the "Extensions" section for website to access "Round and Round" lesson plan of the 2003 Mountains in the Sea Expedition for more information on Taylor columns].

To protect seamount communities, it is essential to understand the reproductive strategies used by benthic seamount species. This is one of the focal points of the Ocean Exploration 2004 Mountains in the Sea Expedition. During the 2003 expedition, scientists deployed blocks of basalt rock within an aggregation of deep-water corals on the Manning Seamount and at a location approximately 50 m outside the aggregation. These blocks provide artificial surfaces on which larval corals may settle. These blocks were recovered during the 2004 expedition and examined for young corals to obtain some insight on the distances coral larvae are transported from parent colonies. In this activity, students will analyze data from a similar experiment, and draw inferences about the reproductive strategy of species that are found on the artificial surfaces.

LEARNING PROCEDURE

1. Explain that seamounts are the remains of underwater volcanoes, and that they are islands of productivity compared to the surrounding environment. Although seamounts have not been extensively explored, expeditions to seamounts often report many species new to science and many that appear to be endemic to a particular group of seamounts. Point out that seamounts are relatively isolated, and explain the meaning of endemic species.

Discuss ways in which planktonic larvae may affect the distribution of species, and ask students to infer advantages and disadvantages that might be associated with a long or short larval phase. Introduce the terms "larval dispersal" (scattering larvae away from parent animals) and "larval retention" (keeping larvae close to the parent animals). Ask students what other factors might affect transport of planktonic larvae. Tell students that scientists refer to the process in which new individuals enter a community as recruitment, and that their assignment is to analyze data on recruitment of several species to artificial substrates, and draw inferences about the reproductive strategies used by these species.

2. Provide each student or student group with a copy of "Recruitment to Artificial Substrates Near Bear Seamount."

Note that these are simulated data, since the actual experiment at Manning Seamount has not been completed.

Have each student or student group summarize the data from the artificial substrates:

- a. Count the number of individuals of each species recruited to each plate.
 - b. Calculate the mean number of individuals of each species recruited for each of the five distances from the benthic community.
 - c. Graph the mean number of individuals of each species recruited (y-axis) as a function of distance from the benthic community (x-axis).
3. Lead a discussion of students' results. Students should realize that larvae of *Metallogorgia* corals were recruited to plates 30 m - 100 m from the benthic community, and this suggests that larval retention may be an important part of the reproductive strategy for these corals. More larvae of *Acanthogorgia*, on the other hand, were recruited to plates 200 m from the benthic community, suggesting that dispersal may be an important part of reproductive strategy of these corals, though they were still relatively close to the parent animals. Very few larvae of *Paragorgia* were recruited to any of the artificial surfaces. This may suggest that dispersal is the primary reproductive strategy for these corals, but there are several other possible explanations as well: perhaps these corals didn't produce as many larvae as the other two genera, or maybe the larvae of *Paragorgia* simply didn't like the artificial surfaces and settled elsewhere. Ask students what sort of experiments they could design to get a better picture of the reproductive strategy of *Paragorgia*.

THE BRIDGE CONNECTION

An interactive activity involving crustacean larvae:
<http://www.vims.edu/bridge/crustacean.html>

THE "ME" CONNECTION

Have students write a short essay in which they imagine they are a coral larva, state whether they would like to have a reproductive strategy that emphasized dispersal or retention, and explain the reasoning behind their choice.

CONNECTIONS TO OTHER SUBJECTS

English/Language Arts, Physical Science

EVALUATION

Data summaries and group discussions offer opportunities for evaluation.

EXTENSIONS

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

RESOURCES

Seamounts website sponsored by the National Science Foundation:

<http://seamounts.edsc.edu/main.html>

Brink, K. H. 1995. Tidal and Lower Frequency Currents Above Fieberling Guyot. *J. of Geophysical Research*, 100:10,817-10,832; and Mullineaux, L. S. and S. W. Mills. 1997. A test of the larval retention hypothesis in seamount-generated flows. *Deep-Sea Research* 44:745-770. A technical journal article about larval dispersal on a seamount

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

- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments

FOR MORE INFORMATION

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ACKNOWLEDGEMENTS

This lesson plan was produced by Mel Goodwin, Ph.D., The Harmony Project, Charleston, South Carolina 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>.

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STUDENT HANDOUT

Recruitment to Artificial Substrates Near Bear Seamount

These diagrams illustrate young corals that were found on a series of artificial substrates deployed for one year in the vicinity of Bear Seamount. The artificial substrates were flat plates of basalt rock measuring 20 cm x 20 cm. The plates were distributed at different distances from a benthic community containing three genera of deep-water corals: *Metallogorgia*, *Acanthogorgia*, and *Paragorgia*

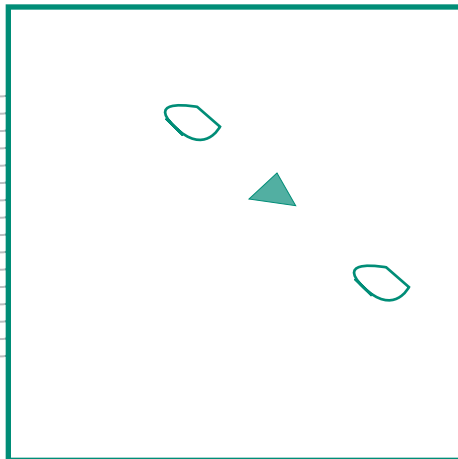


Plate #3241
Distance from benthic community: 3 m

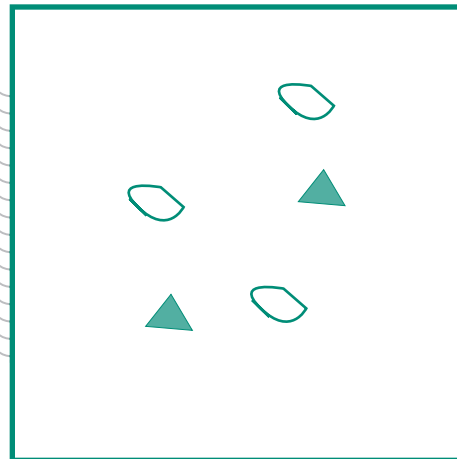


Plate #3242
Distance from benthic community: 3 m

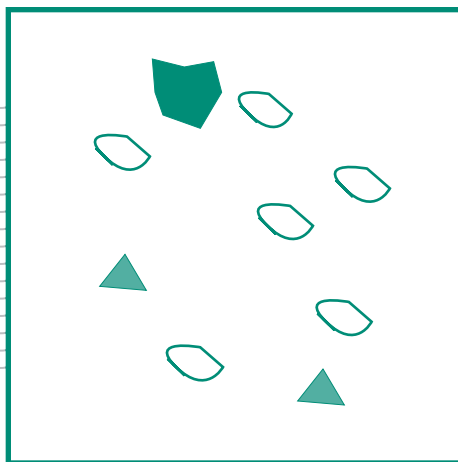


Plate #3243
Distance from benthic community: 30 m

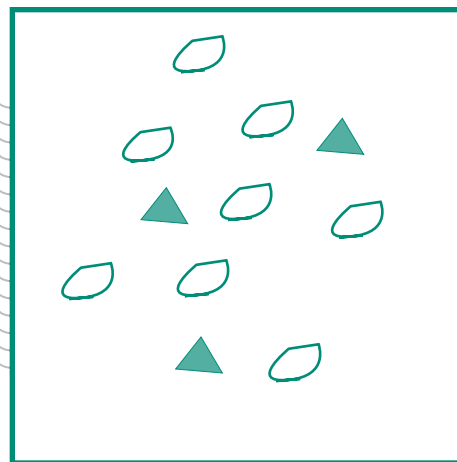


Plate #3244
Distance from benthic community: 30 m

Key

 <i>Metallogorgia</i>	 <i>Acanthogorgia</i>	 <i>Paragorgia</i>
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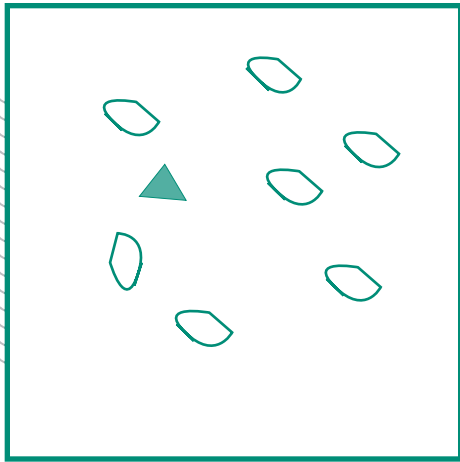


Plate #3245
Distance from benthic community: 100 m

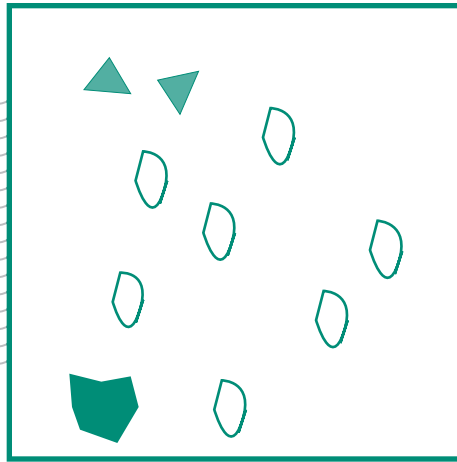


Plate #3246
Distance from benthic community: 100 m

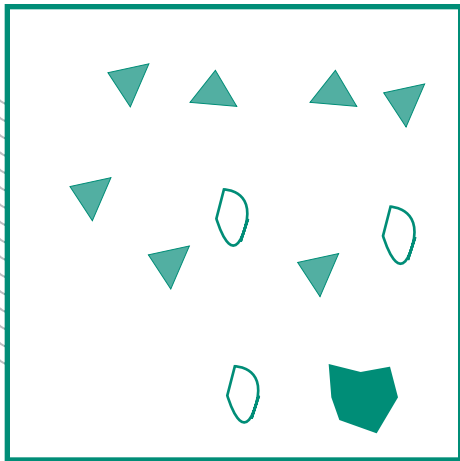


Plate #3247
Distance from benthic community: 200 m

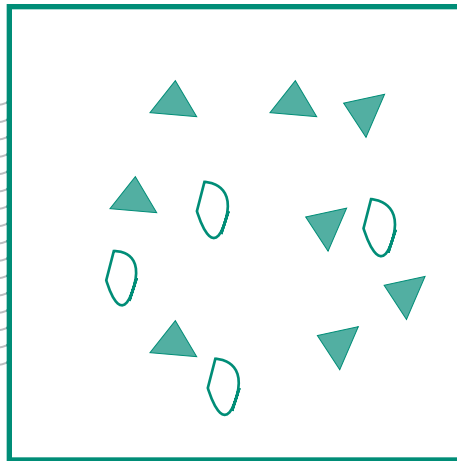


Plate #3248
Distance from benthic community: 200 m

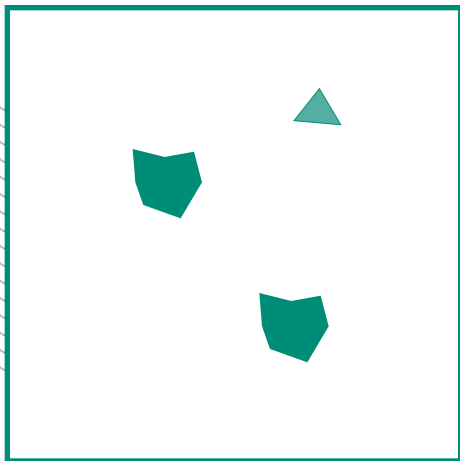


Plate #3249
Distance from benthic community: 500 m

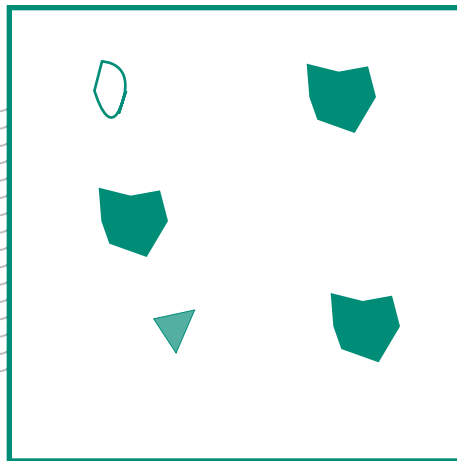


Plate #3250
Distance from benthic community: 500 m