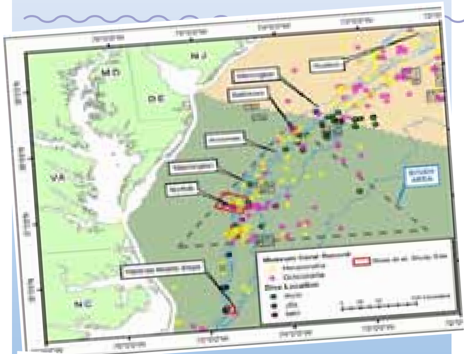
OCEAN EXPLORATION & RESEARCH

Deepwater Canyons 2012 - Pathways to the Abyss

Feeding in the Flow

(adapted from the 2003 Charleston Bump Expedition)



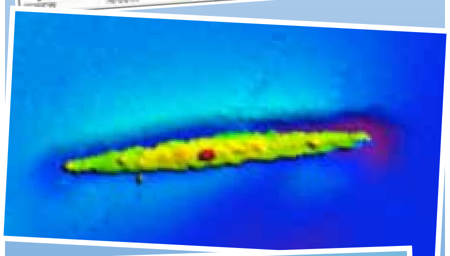


Image captions/credits on Page 2.

lesson plan

Focus
Effect of water currents on food capture in corals

Grade Level
9-12 (Life Science)

Focus Question
How do water currents affect food capture by particle feeders?

Learning Objectives
- Students will analyze and interpret data to explain how the structure of a particle-feeding organism may affect the organism's ability to capture food.
- Students will obtain, evaluate, and communicate information to explain how at least two environmental factors, in addition to current, may affect the morphology of reef-building corals.

Materials
- ❑ Copies of *Methods for a Study of Water Flow and Prey Capture by Three Corals* and *Data on Water Flow and Prey Capture by Three Corals*; one for each student group

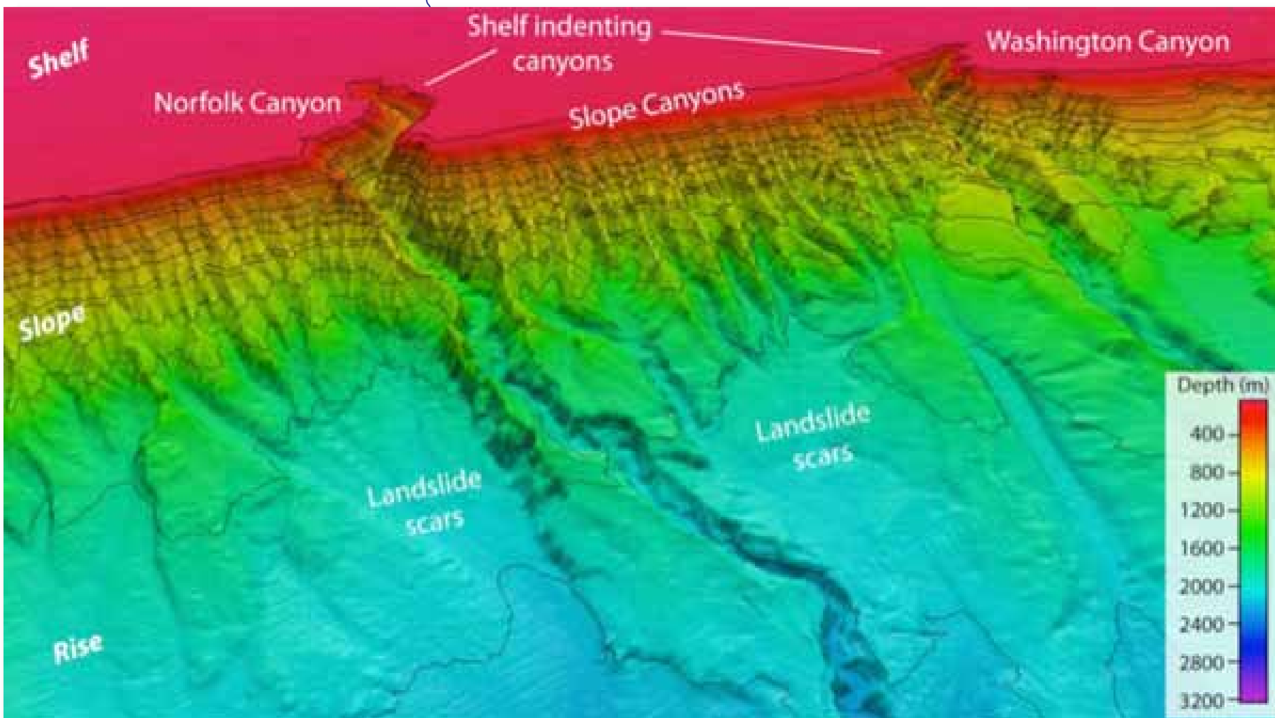
Audio-Visual Materials
- ❑ (Optional) Interactive white board

Teaching Time
Two 45-minute class periods, plus time for student research

Seating Arrangement
Groups of two or three students

Maximum Number of Students
30

Key Words
Atlantic canyon
Habitat
Deep-water coral
Microhabitat
Current



Deep submarine canyons are perhaps the most striking feature of the continental margin of the eastern United States. Most of these canyons are relatively minor features, but several are incredibly extensive and cut quite deeply into the seafloor. This image shows the Norfolk and Washington Canyons along the continental margin offshore of Virginia. Image courtesy of USGS. http://oceanexplorer.noaa.gov/explorations/11midatlantic/background/seafloormapping/media/seafloormapping_fig3.html

Images from Page 1 top to bottom:
The primary target areas for the Deepwater Mid-Atlantic Canyons Project are in and around the Norfolk, Washington, Accomac, and Baltimore Canyons. This map shows places where deep-sea corals were previously identified (indicated by yellow and pink stars) as well as locations of previous submersible dives (green, blue, and red circles). Image courtesy SW Ross, UNC-W. http://oceanexplorer.noaa.gov/explorations/11midatlantic/hires/plan_fig0_hires.jpg

High-resolution multibeam sonar image of a shipwreck on the continental shelf near Norfolk Canyon. Image courtesy R Mather, URI. http://oceanexplorer.noaa.gov/explorations/11midatlantic/hires/plan_fig1_hires.jpg

Benthic landers, designed at the University of North Carolina – Wilmington, will be used during the Deepwater Mid-Atlantic Canyons Project. They provide a way to deploy multiple instruments and experiments to the deep-sea floor and collect precise time-series data on environmental variability that is typically unattainable. Image courtesy SW Ross, UNC-W. http://oceanexplorer.noaa.gov/explorations/11midatlantic/hires/plan_fig6_hires.jpg

3D rendering of a submarine canyon system just north of Cape Hattaras, NC which illustrates both the rugged canyon topography and the kind of detail that is possible to obtain from multibeam sonar mapping. Image courtesy SW Ross, UNC-W. http://oceanexplorer.noaa.gov/explorations/11midatlantic/hires/plan_fig4_hires.jpg

Background Information

NOTE: Explanations and procedures in this lesson are written at a level appropriate to professional educators. In presenting and discussing this material with students, educators may need to adapt the language and instructional approach to styles that are best suited to specific student groups.

Deepwater canyons are among the most striking features of the continental slope off the east coast of the United States. There are more than 70 of these canyons in depths ranging from about 100 m to about 3,500 m, with steep, narrow walls that make exploration difficult. Research during the 1970's and 1980's (Hecker *et al.*, 1980; Hecker and Blechschmidt, 1979) showed that submarine canyons along the mid-Atlantic continental slope can contain unique hard bottom communities, many of which include high densities of deepwater corals.

Habitat complexity in submarine canyons results from a combination of geological and biological features. Steep canyon walls, rocky outcrops, hard clay formations, boulders, rock rubble, and soft sediments all provide surfaces upon and within which various benthic organisms may grow. Sessile (non-moving) species such as sponges and cnidarians increase the surface complexity and provide additional habitat for other species. Soft sediment is the major substrate type, and most mid-Atlantic canyons have extensive holes and tunnels produced by crabs, tilefish, burrowing anemones, and other animals that further extend the range of available habitats.

Shipwrecks are another type of substrate known to be present in mid-Atlantic canyons, and have historical as well as ecological significance. The mid-Atlantic coast of the United States has a maritime history that spans more than 400 years, and is marked by numerous shipwrecks that are neither well-documented nor well-understood. Shipwrecks, like many other human artifacts, can provide hard surfaces that may be associated with a high biomass of biologically diverse organisms. Deterioration of shipwrecks can enhance the settlement of some organisms (e.g., corals; see "Corrosion to Corals." http://oceanexplorer.noaa.gov/explorations/08lophelia/background/edu/media/corrosion.pdf), but the importance of artificial substrates to natural ecosystems is not clear. In areas with a low percentage of natural hard substrates (such as mid-Atlantic submarine canyons), shipwrecks may represent a significant habitat resource for benthic organisms.

The purpose of the Deepwater Canyons 2012 - Pathways to the Abyss expedition is to explore and investigate deepwater coral and hard bottom communities and shipwreck sites on the continental slope off of Virginia, Maryland, and Delaware. These studies are expected to discover new coral areas and other significant canyon habitats and provide information about processes that control their distribution, abundance, and ecological functions. Selected shipwreck sites will be studied to determine their historical significance and their ecological function as artificial substrates for deepwater organisms.

To achieve these goals, expedition explorers will:

- Prepare detailed bathymetric maps of the three canyons in the study area using a multibeam sonar system;
- Collect video and still imagery from the survey area that will provide information about the presence, identity, and distribution of living organisms, as well as structural characteristics (size, shape, complexity, area covered) of various habitats resulting from biological and geological components;
- Collect samples for genetic, biological, ecological, and geological studies; and
- Measure temperature, salinity, turbidity, dissolved oxygen, and bottom currents in the three canyons and adjacent locations in the study area;

For additional information about methods and technologies used by expedition explorers, please see the Expedition Education Module for the Deepwater Canyons 2012 - Pathways to the Abyss expedition.

Lophelia pertusa is the most abundant deepwater coral species found in the canyons and shipwrecks off the eastern U.S. coast. These corals typically prefer water temperatures between 4-12 °C, dissolved oxygen concentrations above 3 ml/l, and salinity between 35 and 37 ppt. The influence of other factors, including pH, is not known. Corals are members of the phylum Cnidaria whose members are characterized by having stinging cells (nematocysts) that are used for feeding and defense. In addition to hard and soft corals, this phylum also includes sea fans, sea anemones, jellyfish, and hydroids. *L. pertusa* and other hard corals belong to the Scleractinia, within the class Anthozoa. Individual coral animals are called polyps, each of which has an internal skeleton made of limestone (calcium carbonate). In many coral species, including those that build reefs, the polyps form colonies composed of many individuals whose skeletons are fused together. In other species, the polyps live as solitary individuals. Each polyp has a ring of flexible tentacles surrounding an opening to the digestive cavity. The tentacles contain nematocysts that usually contain toxins used to capture prey or discourage predators. Corals are sessile (they stay in one spot) and depend upon currents to bring food within the reach of their tentacles. *L. pertusa* feeds on a variety of phytoplankton and zooplankton species, as well as dead materials.

The skeletons of individual corals are basically cup-shaped and provide protection as well as support for soft tissues. The fused skeletons of colonial corals may form boulders, plate-like structures, or complex branches. Large coral reefs develop over hundreds of years; some *L. pertusa* reefs are estimated to be more than 8,000 years old. As the corals reproduce, the skeletons of new corals grow on top of the skeletons of corals that have died (the lifespan of a single polyp is estimated as 10 – 15 years). *L. pertusa* grows at a rate that has been estimated to range between 4-25 mm per year, and produces complex branches and bushy colonies. This growth form aids feeding by reducing fast currents that could otherwise deform the soft polyps, and also produces strong and complex physical structures. Occasionally, highly branched colonies may partially collapse, producing rubble that traps sediments that add to reefs' stability. Over time, repeated cycles of coral growth, collapse, and sediment entrapment can produce large reefs and mounds that provide habitats for many other species. For additional information about reproduction and biogeography of *L. pertusa*, please see the Expedition Education Module for the *Lophelia* II 2012: Deepwater Platform Corals Expedition (http://oceanexplorer.noaa.gov/explorations/12lophelia/background/edu/edu.html).

In this lesson, students will analyze data from research on water motion and feeding behavior of corals, and will infer how water currents and external morphology may affect the food capture of some particle-feeding organisms.

Learning Procedure

1. To prepare for this lesson:

   Review the background essays for the Deepwater Canyons 2012 - Pathways to the Abyss Expedition (http://oceanexplorer.noaa.gov/explorations/12midatlantic/welcome.html). You may also want to download images of *Montastrea cavernosa*, *Madracis mirabilis*, and *Porites porites* to include with discussions in Step 6.

2. Briefly introduce the Deepwater Canyons 2012 - Pathways to the Abyss expedition and describe deepwater canyon habitats. Mention some of the reasons for exploring these habitats, which include the facts that similar sites in other areas are known to support important fisheries and other biological resources, and that cold seep communities may exist in some locations. If students are not familiar with cold seep habitats, briefly describe these (see the Expedition Education Module for the Lophelia II 2012: Deepwater Platform Corals Expedition, http://oceanexplorer.noaa.gov/explorations/12lophelia/background/edu/edu.html, for more details). Point out the significance of potential methane hydrate deposits, including their potential as a new energy source as well as their potential for triggering underwater landslides that can result in tsunamis.

   Tell students that while these canyons have not been extensively explored, deep-water corals are one of the most conspicuous organisms seen in previous explorations. Water motion has a significant influence on biological communities in many bottom habitats, and it is likely that these corals create microhabitats for other organisms by modifying water motion over the bottom. If students are not familiar with the basic morphology of corals, briefly review these features (see Background Information for more details). Students should understand that the corals we often see in pictures are colonies of individual animals called polyps, and that coral colonies may grow in a variety of shapes: branches, boulders, plates, fans, whips, etc.

3. Tell students that both shallow- and deep-water corals are often exposed to strong water motion. Have each group brainstorm how water motion may affect corals, and record their ideas for discussion later.

4. Provide each student group with a copy of *Methods for a Study of Water Flow and Prey Capture by Three Corals* and *Data on Water Flow and Prey Capture by Three Corals*. Tell students that their assignment is to prepare a short summary of how this investigation was done, and to analyze the experimental data to make inferences about how current flow affects food capture in each of the three coral species.

Each group should record their analyses and conclusions in a written report.

5. Lead a discussion of students' results. Ideas about how water motion might affect corals could include speculation that strong currents or waves might break the colonies or dislodge them from the bottom (branched growth forms are particularly vulnerable to this). Very strong water motion can also flatten the soft tentacles, making feeding more difficult. On the positive side, currents can bring food to the polyps (an important benefit for animals that cannot move around very much), and may also carry away waste products, and keep sediment from settling on the surface of the corals.

   Students should explain that researchers placed colonies of these three species in plankton-free underwater cages for 6-24 hours, then moved the colonies into underwater enclosures on reef areas that were exposed to different current strengths. The enclosures were screened to exclude zooplankton. Brine shrimp cysts ("eggs") were injected into the enclosures to study how well the corals could remove particulate material under different current strengths. The corals were allowed to feed on zooplankton for about 20 minutes, then were preserved so that the stomach contents of individual polyps could be examined.

   Graphing the experimental data is an effective approach to developing analyses and explanations. Interpretation of the data is assisted by the following information on the morphology of the three coral species presented at the beginning of the *Methods* document. Students should recognize that increased current flow was correlated with increased particle (cyst) capture by *M. mirabilis* and *M. cavernosa*. Students may notice that *M. cavernosa* had fairly high capture rates, even at lower flow speeds. *P. porites* had low capture rates at all flow speeds, though the highest capture rates also occurred at flow rates of 9 -11 cm/sec and declined at the highest flow speeds. Explanations for these results may postulate that increasing flow speeds would be expected to bring more food past the coral polyps in a given amount of time, and the fact that increasing capture rates were correlated with increasing flow suggests that the corals were able to take advantage of this.

   Ask students why *M. cavernosa* seemed to have fairly high capture rates at lower current speeds. One explanation is that the low, boulder-shaped growth form of this species can take advantage of particles that settle out of the water column by gravity, adding to the particles obtained through direct capture by the polyps' tentacles. Another factor might be the larger size of the *M. cavernosa* polyps.

Ask why rates of particle capture by *P. porites* seemed to decline at flow speeds above 11 cm/sec. A possible explanation is that the polyps' tentacles were flattened or collapsed at the high flow speeds, reducing their effectiveness in capturing particles. Tell students that tentacles of *M. mirabilis* have been found to collapse at flow rates of 10 - 15 cm/sec, but colonies of this coral have still been able to capture particles from flows of 40-50 cm/sec. The explanation for this apparent contradiction lies in interactions between current flow and the coral's morphology: branches of the coral colony modify water movement so that polyps on the downstream side of the colony are not flattened, and may even benefit from eddies that concentrate particles in the downstream area.

Remind students that corals also feed on zooplankton, and ask whether they would expect current flow to have a similar effect on capture rates for these animals. A major difference between zooplankton and particles is that most zooplankton can swim, and often have behaviors that allow them to escape from predators. For some species of zooplankton, though, studies have shown that increased current flow is also correlated with increased capture by coral polyps.

Ask students to think of other environmental factors that might affect the growth form of corals. High rates of sedimentation, for example, would favor upright or branched growth forms that could shed sediment more easily than horizontal or boulder-shaped growth forms. Corals that contain zooxanthellae may benefit from growth forms (like flattened plates) that maximize exposure to light.

The BRIDGE Connection

www.vims.edu/bridge/ – Scroll over "Ocean Science Topics" in the navigation menu to the left, then "Habitats," then "Coastal," then "Coral" for resources on corals and coral reefs. Click on "Physics" for resources on ocean currents.

The "Me" Connection

Have students write a short essay on ways in which humans are adapted to specific physical conditions in their environment.

Connections to Other Subjects

English Language Arts, Mathematics, Earth Science

Assessment

Student reports and class discussions provide opportunities for assessment.

Extensions

Have students visit http://oceanexplorer.noaa.gov/explorations/12midatlantic/welcome.html to find out more about the Deepwater Canyons 2012 - Pathways to the Abyss Expedition.

Multimedia Discovery Missions

http://oceanexplorer.noaa.gov/edu/learning/welcome.html Click on the links to Lessons 3, 5, 6, and 8 for interactive multimedia presentations and Learning Activities on Deep-Sea Corals, Chemosynthesis and Hydrothermal Vent Life, Deep-Sea Benthos, and Ocean Currents.

Other Relevant Lesson Plans from NOAA's Ocean Exploration Program

Cool Corals
(from the 2003 Life on the Edge: Exploring Deep-Ocean Habitats Expedition)
http://oceanexplorer.noaa.gov/explorations/03edge/background/edu/media/cool.pdf

Focus: Biology and ecology of *Lophelia* corals (Life Science)

Students describe the basic morphology of *Lophelia* corals and explain the significance of these organisms, interpret preliminary observations on the behavior of *Lophelia* polyps, infer possible explanations for these observations, and discuss why biological communities associated with *Lophelia* corals are the focus of major worldwide conservation efforts.

What's the Big Deal?
(from the 2003 Windows to the Deep Expedition)
http://oceanexplorer.noaa.gov/explorations/03windows/background/education/media/03win_bigdeal.pdf

Focus: Significance of methane hydrates (Life Science)

Students define methane hydrates, describe where these substances are typically found and how they are believed to be formed, describe at least three ways in which methane hydrates could have a direct impact on their own lives, and describe how additional knowledge of methane hydrates expected from the Blake Ridge expedition could provide human benefits.

This Life Stinks
(from the 2003 Windows to the Deep Expedition)
http://oceanexplorer.noaa.gov/explorations/03windows/background/education/media/03win_lifestinks.pdf

Focus: Methane-based chemosynthetic processes (Physical Science)

Students define the process of chemosynthesis, and contrast this process with photosynthesis. Students will also explain the process of methane-based chemosynthesis and explain the relevance of chemosynthesis to biological communities in the vicinity of cold seeps.

How Diverse is That?
(from the 2003 Windows to the Deep Expedition)
http://oceanexplorer.noaa.gov/explorations/03windows/background/education/media/03win_hdiverse.pdf

Focus: Quantifying biological diversity (Life Science)

Students discuss the meaning of "biological diversity" and will be able to compare and contrast the concepts of "variety" and "relative abundance" as they relate to biological diversity. Given abundance and distribution data of species in two communities, students will be able to calculate an appropriate numeric indicator that describes the biological diversity of these communities.

Keep It Complex!
(from the 2003 Charleston Bump Expedition)
http://oceanexplorer.noaa.gov/explorations/03bump/background/education/media/03cb_complex.pdf

Focus: Effects of habitat complexity on biological diversity (Life Science)

Students describe the significance of complexity in benthic habitats to organisms that live in these habitats and will describe at least three attributes of benthic habitats that can increase the physical complexity of these habitats. Students will also be able to give examples of organisms that increase the structural complexity of their communities and infer and explain relationships between species diversity and habitat complexity in benthic communities.

Tools for Classroom Explorers – How to Use ROV Imagery
(from the NOAA Ship *Okeanos Explorer* Gulf of Mexico 2012 Expedition)
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/background/edu/media/ex1202_rov.pdf

Focus: ROV imagery and exploration activities during the NOAA Ship *Okeanos Explorer* Gulf of Mexico 2012 Expedition (Earth Science)

Students will describe typical applications and limitations of imagery obtained with ROVs, demonstrate how lasers may be used to calibrate images for size and distance measurements, and analyze ROV imagery from the *Okeanos Explorer* to make inferences about deep-ocean habitats and organisms.

Okeanos Explorer ROV Imagery Supplemental Datasheet #1 for Cruise 12.02
(from the NOAA Ship *Okeanos Explorer* Gulf of Mexico 2012 Expedition)
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/background/edu/media/ex1202_sdrov1.pdf

Focus: ROV imagery interpretation (Earth Science)

Students interpret ROV imagery collected by the *Okeanos Explorer* during the Gulf of Mexico 2012 Expedition.

Other Resources

The Web links below are provided for informational purposes only. Links outside of Ocean Explorer have been checked at the time of this page's publication, but the linking sites may become outdated or non-operational over time.

http://oceanexplorer.noaa.gov/explorations/12midatlantic/welcome.html – Web site for the Deepwater Canyons 2012 - Pathways to the Abyss expedition

De Leo, F. C., C. R. Smith, A. A. Rowden, D. A. Bowden, and M. R. Clark. 2010. Submarine canyons: hotspots of benthic biomass and productivity in the deep sea. Proc. Biol. Sci. 277(1695):2783-2792.

Hecker, B. and G. Blechschmidt. 1979. Final Historical Coral Report for the Canyon Assessment Study in the Mid- and North-Atlantic Areas of the U.S. Outer Continental Shelf. Manuscript report prepared for U. S. Department of the Interior, Bureau of Land Management. Washington, DC; available online at http://www.gomr.mms.gov/PI/PDFImages/ESPIS/4/4487.pdf

Hecker, B. and G. Blechschmidt, and P. Gibson. 1980. Epifaunal Zonation and Community Structure in Three Mid- and North Atlantic Canyons. Final Report for the Canyon Assessment Study in the Mid- and North-Atlantic Areas of the U.S. Outer Continental Shelf. Manuscript report prepared for U. S. Department of the Interior, Bureau of Land Management. Washington, DC; available online at http://www.gomr.mms.gov/PI/PDFImages/ESPIS/4/4436.pdf

ten Brink, U. 2009. Submarine Landslides as Potential Triggers of Tsunamis That Could Strike the U.S. East Coast – First results from systematic sea-floor mapping of the continental slope from Cape

Hatteras to Georges Bank. [Internet]. U. S. Geological Survey [cited May 16, 2011]. Available from: http://soundwaves.usgs.gov/2009/08/fieldwork.html

Sebens, K. P., S. P. Grace, B. Helmuth, E. J. Maney Jr, and J. S. Miles. 1998. Water flow and prey capture by three scleractinian corals, *Madracis mirabilis*, *Montastrea cavernosa* and *Porites porites*, in a field enclosure. Marine Biology 131: 347-360. Available from: http://www.users.muohio.edu/boardmmr/GLG415/ReefReadings/Sebens98_CoralFilterPlankt.pdf

Relationship to *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*

The objectives of this lesson integrate the following Practices, Crosscutting Concepts, and Core Ideas:

Objective: Students will analyze and interpret data to explain how the structure of a particle-feeding organism may affect the organism's ability to capture food.

Science and Engineering Practices:
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations

Crosscutting Concepts:
2. Cause and effect
6. Structure and function

Disciplinary Core Ideas:
LS1.A Structure and Function

Objective: Students will obtain, evaluate, and communicate information to explain how at least two environmental factors in addition to current may affect the morphology of reef-building corals.

Science and Engineering Practices:
6. Constructing explanations
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts:
2. Cause and effect
6. Structure and function

Disciplinary Core Ideas:
LS1.A Structure and Function

Correlations to Common Core State Standards for Mathematics

Modeling

Correlations to Common Core State Standards for English Language Arts

RI.4 – Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings

SL.1 – Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 9-12 topics, texts, and issues, building on others' ideas and expressing their own clearly.

L.4 – Determine or clarify the meaning of unknown and multiple-meaning words and phrases, choosing flexibly from a range of strategies

L.6 – Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 1.
The Earth has one big ocean with many features.
Fundamental Concept b. An ocean basin's size, shape and features (such as islands, trenches, mid-ocean ridges, rift valleys) vary due to the movement of Earth's lithospheric plates. Earth's highest peaks, deepest valleys and flattest vast plains are all in the ocean.

Essential Principle 5.
The ocean supports a great diversity of life and ecosystems.
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.
Fundamental Concept f. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.
Fundamental Concept g. There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, and methane cold seeps

rely only on chemical energy and chemosynthetic organisms to support life.

Essential Principle 6.
The ocean and humans are inextricably interconnected.
Fundamental Concept f. Coastal regions are susceptible to natural hazards (such as tsunamis, hurricanes, cyclones, sea level change, and storm surges).

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 b. Understanding the ocean is more than a matter of curiosity. Exploration, inquiry and study are required to better understand ocean systems and processes.
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.

Send Us Your Feedback

In addition to consultation with expedition scientists, the development of lesson plans and other education products is guided by comments and suggestions from educators and others who use these materials. Please send questions and comments about these materials to: oceanexeducation@noaa.gov.

For More Information

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Credit

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Methods for a Study of Water Flow and Prey Capture by Three Corals

(adapted from Sebens *et al.*, 1998)

Madracis mirabilis (Duchassaing and Michelotti) grows as an aggregation of narrow branches with small polyps (3 to 4 mm tentacle crown diameter); *Montastrea cavernosa* (Linnaeus) is a large mound-forming species with larger polyps (11 to 14 mm tentacle crown diameter), and *Porites porites* (Pallas) forms colonies of few wide branches with small polyps (3 to 4 mm tentacle crown diameter). Corals were collected on the forereef at Discovery Bay, Jamaica (November 1989 to January 1992 at depths of 12 to 18 m) and moved adjacent to experimental enclosures. Individual branches of *M. mirabilis* were positioned upright on four plastic tubing holders (15 x 10 x 10 mm) glued to Plexiglas plates, placing branches at least 5 cm apart laterally. Colonies (8 to 12 cm diameter) of *M. cavernosa* and branches of *P. porites* were attached to 15 x 30 cm Plexiglas plates (using underwater epoxy), being careful not to let the epoxy touch the living coral tissue. Corals on their mounting plates were placed in depressions on the reef for 1 d or more, then moved into an "isolator" at least 6 h (usually 24 h) before they were used in experiments. The isolator was a large Plexiglas enclosure 50 x 50 x 30 cm, with two ends covered by nylon mesh (cleaned daily). The isolator prevented corals from being exposed to ambient plankton until the experiment began, although a few zooplankton could move in and out of the isolator when the lid was open. Corals expanded completely in the isolator, as on the reef, then expanded again rapidly and were ready to feed within minutes when transferred to the enclosure, as long as their live tissue surfaces were not touched during the transfer. The two enclosures consisted of a large, two-piece, Plexiglas channel (150 x 40 x 25 cm) painted black on all sides. Each end was covered by nylon mesh. Flow at this site (10 m depth) was generally oscillatory, with a slightly greater flux toward shore than away from shore.

Zooplankton were attracted into the enclosure at the beginning of each experiment using one or more dive lights placed inside one end, facing through the enclosure such that plankton had to swim in through the opposite end or through the lid on top. Other potential methods of providing plankton to the corals would have involved collecting them with nets, which could damage them or potentially change their behavior. The nylon mesh end pieces were placed on the enclosure after the concentration of plankton had reached the desired density, and the light was removed. The enclosure was painted black to prevent plankton from collecting on the upper surface on nights with strong moonlight.

After zooplankton were well-distributed throughout the enclosure, corals were removed from the isolators, carried by the plastic holders, and placed into the enclosure. Live coral surfaces were never touched; most corals thus expanded and began feeding within a minute or two after being placed in the enclosure, and any corals that did not expand rapidly were omitted from the experiment. Corals fed for approximately 20 ± 5 min and then all were tapped by hand repeatedly to cause polyp contraction. Corals were removed and taken to the surface and preserved (10% formalin in seawater) within a few minutes. This ensured that digestion of prey would be minimal before preservation. To examine coelenteron contents, corals were placed in 10% buffered formalin in seawater at the end of each experiment, and were kept in that solution until the polyp coelenterons could be examined. Polyps were searched and the identity and length of each prey item were recorded for each polyp, as were the location of each polyp on the coral head, and the number of polyps without prey.

Data on Water Flow and Prey Capture by Three Corals

Madracis mirabilis		*Montastrea cavernosa*		*Porites porites*	
Flow Speed (cm/sec)	Cyst Capture *	Flow Speed (cm/sec)	Cyst Capture *	Flow Speed (cm/sec)	Cyst Capture *
1.1	0.1	2.5	0.8	2.5	0.0
1.9	0.2	3.2	6.5	3.4	1.3
2.5	0.5	3.3	6.6	3.4	1.8
3.2	0.5	3.7	4.5	3.4	3.8
3.6	0.2	3.9	4.4	4.0	0.0
4.1	0.5	4.0	1.5	4.0	0.3
4.5	0.3	4.1	1.4	4.0	1.1
4.6	0.7	4.2	1.7	5.5	0.4
5.0	1.1	4.3	5.5	5.6	0.3
5.1	1.0	4.4	3.5	5.7	0.5
5.2	0.8	4.4	1.0	5.8	0.0
5.5	1.9	4.4	2.0	5.8	0.2
6.1	0.7	5.4	4.8	6.1	0.0
6.4	1.1	5.4	1.0	6.1	0.3
6.5	0.9	5.8	1.0	6.1	0.5
7.1	2.8	5.8	1.2	6.1	0.6
7.1	2.7	7.8	0.5	7.0	0.7
7.4	0.8	8.1	2.0	8.2	0.5
7.5	1.2	8.3	5.0	8.6	2.1
7.6	1.2	9.5	4.5	8.7	3.0
7.6	2.1	9.5	7.0	10.2	0.3
8.2	1.7	10.0	10.0	10.2	2.8
8.5	0.5			10.2	4.5
9.5	4.0			10.2	4.7
10.1	0.4			10.2	6.3
10.1	7.0			10.3	0.5
11.5	0.8				
				12.0	0.8
				12.5	0.5

* – Number of cysts captured per polyp during a 20-minute experiment