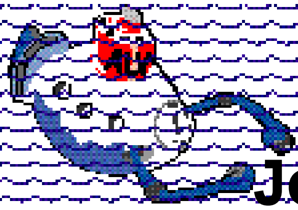


Journey to the Unknown

Focus
Ocean Exploration

Grade Level
5-6

Focus Question
What information can you use to determine where you are in an unknown area?

Learning Objectives
Students will experience the excitement of discovery and problem-solving to learn what organisms could live in extreme environments in the deep ocean.

Students will understand the importance of ocean exploration.

Adaptations for Deaf Students
Vocabulary:
- Be sure to pre-teach all vocabulary.
- Additional words: realm and exploration

Pre-Teaching Activity:
- Use Extension #2 to lead into this lesson.

Learning Procedure Section:
- Eliminate Step 1.
- Step 3 is optional, depending on hearing levels of students.
- Have the entire class work as one team during the "Why Do We Explore?" activity.

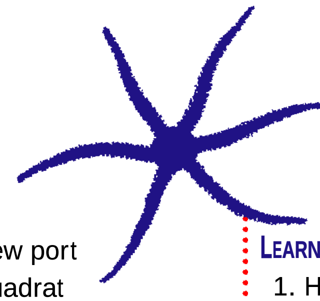
Materials
- ❒ NOAA and Woods Hole Oceanographic Institute (WHOI) photos of deep sea animals (See www.atlantisforce.org/canylife.html. Other useful deep-sea animal pictures can be found at http://extremescience.com/deepcreat.htm http://tqjunior.thinkquest.org/4106, and http://www.ocean.udel.edu/deepsea/gallery/gallery.html
- ❒ WHOI Posters of Deep Sea Sites (optional)
- ❒ Octacoral photos (www.oceanexplorer.noaa.gov and www.atlantisforce.org)
- ❒ Diagram/photo of ALVIN
- ❒ Audiotape or CD of mysterious music and engine sounds
- ❒ One pint Ziploc bag of sand
- ❒ One pint Ziploc bag of mud
- ❒ Deep East Voyage of Discovery Information Sheets from Ocean Explorer web site
- ❒ Student Data Sheet – 1 per student for use with Extension #2
- ❒ Why Do We Explore? Student Sheet (1 per group of 3-4 students)

Audio/Visual Equipment
- ❒ Cassette tape player, CD player, or computer with CD drive

Teaching Time
Two periods of 45 minutes each

Seating Arrangement
Groups of 3 or 4 students

Maximum Number of Students
30 students



Key Words

- Explore
- Technology
- Submersible
- Biodiversity
- Manipulator arm
- Manipulator claw
- View port
- Quadrat
- Transect
- Core sample
- Tube corer
- Sample basket
- Sediment

Background Information

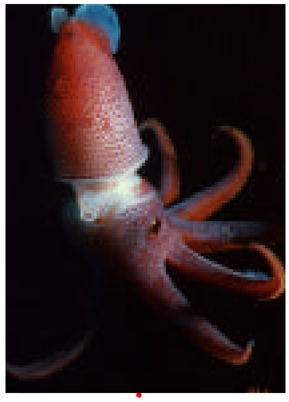
Today, we have sophisticated technologies that make the ocean more "visible" and more accessible than it has ever been before. As a result of "new technological eyes," hundreds of new species and new ecosystems have been discovered—some of which may hold the keys to the origin of life on Earth, cures for life-threatening diseases, and knowledge about presently unknown metabolic pathways for obtaining and using energy to support life here on Earth.

Even though we live on an Ocean Planet, more than two-thirds of which is covered by water, approximately 95% of the ocean remains unexplored. Recent progress in technology permits us to completely rethink how we conduct exploration and oceanographic studies. Developments in biotechnology, sensors, telemetry, power sources, microcomputers, and materials science now permit the U.S. to dream of rivaling space exploration in our ability to go to and study the undersea frontier. We need not be limited by weather and blind sampling from ships, but like the true explorers, can immerse ourselves in new places and events. The National Oceanographic and Atmospheric Administration (NOAA) has embarked on a national endeavor, to build on our initial exploration programs outside of NOAA, and to achieve international leadership in undersea exploration and research.

Learning Procedure

1. Have students close their eyes.
2. Tell them that they are going on an expedition.
3. Turn on a tape or CD player with a tape or CD of recorded mysterious music, engine, and underwater sounds.
4. Describe an actual ALVIN dive without saying that you are going underwater, as described in a.- n. below. Do not read the words in parentheses.
   a. You are a scientist on a mission.
   b. You enter a small vehicle with three seats in a small cramped area.
   c. You settle yourself into the seat on the right side of the vehicle.
   d. Engines begin to whir as your vehicle slowly begins to move forward, rocking gently, and you begin to enter another realm. It sounds similar to an outboard motor in the water.
   e. You hear the whine of thrusters begin. The pilot switches on buttons and you're off! The vehicle's tanks begin to fill and other engines start. You hear the pilot talking to the mother ship. She is communicating your vehicle's direction and her observations. "I have a heading of 030. I see many creatures. It is getting darker and I am switching on the outside lights." Several hours later, you begin closing in on your destination.
   f. The interior and exterior cameras are frantically switched on as new and amazing objects and organisms whiz by.
   g. You are fascinated by the array of things you can see from your viewing port.
   h. Suddenly, a glowing object moves past. "WHAT WAS THAT???" *(Bioluminescent fish or other organisms.)* It seems to be following another object. It moves out of

your range of viewing. You busily begin speaking into your recorder to excitedly record every amazing sight that you see in detail.



i. You see that your vessel is settling onto a surface and you begin to observe objects there. Large branching objects come into view. You request that the pilot collect a few of these with the claw or the manipulative arm and put them into the sample basket. (*Deep sea corals*)

j. Farther ahead, you see something interesting scurry into the mud. "Pilot," you say, "Quick! Take a core sample seven meters ahead! Things are moving in the mud!" *(Polychaete worms)*

k. Slowly, she lowers the tube corer to the surface. She uses the manipulative arm to press it about 30 centimeters into the surface. Then she pulls it up and returns it to the quiver where it was stored. It looks like an interesting core sample!

l. Your attention is caught by a dial on the control panel. It reads 2000 meters! It is incredible that the bottom is covered with animals, tracks, and holes.

m. The captain deploys a video camera and records what you are seeing.

n. All too soon, the pilot indicates that it is time to return to the mother ship. You ascend slowly, totally amazed by what you have seen through your viewport—things that you have never seen before in your entire life. You cannnot wait to begin analyzing and observing the new sediments and species that have been collected for your research project.

5. Have students open their eyes and have a discussion about where they think that they have been and why? Stimulate the discussion by asking the following:
Were you excited? Why was it dark? What was the glowing object? The branching objects?
What were the things moving in the mud?
What was the dial that read 2000 meters?
What were you thinking as the vessel moved around?
Would you have been frightened if you had actually been on board?
Do you think that scientists get excited when they are making discoveries?

6. Tell your students that you are going to provide them with some materials to help them try to determine where they went on their imaginary voyage. Give each table copies of several photos of deep sea creatures, a picture of ALVIN, a Ziploc bag full of sand and one of mud. (Do not explain the materials yet.) Tell the students to think about the things that they saw and heard, including the pilot's words. Give them 10-15 minutes to explore, discuss, ask questions.

7. As a class, have students discuss their ideas, answering questions, and challenging ideas. Then tell them that they were on an imaginary trip aboard a deep-sea submersible and now they are going to learn about places being visited by the Woods Hole Oceanographic Institute's submersible, ALVIN. Tell the students that they will be able to collect data, see pictures, and communicate with the people on ALVIN. Bring out Woods Hole posters of deep

sea sites. Discuss the Deep East Voyage of Exploration and why it is important.

8. Play the Why Do We Explore game? (See attached activity adapted from NASA's Destination to Mars)

The BRIDGE Connection

www.vims.edu/bridge

Choose Elementary from sidebar, then 5th Grade, and then Ocean Planet: Interdisciplinary Marine Science Activities

The "Me" Connection

Have a discussion of products from the sea, potential to discover new species, new medicines, and new ways of transferring energy. (Use www.ohia.com and www.coralreefalliance.org/aboutcoralreefs Web sites from Resources section.)

Connections to Other Subjects

Biology, English/Language Arts, Mathematics

Evaluation

Have students write a log entry with illustrations about what was seen on the deep sea dive. Ask them to include the newly-learned vocabulary terms in their entry.

Extensions

1. Science - Research the Internet to find more species that live at depths of 2,000 meters and beyond. Make a poster using the information about a particular animal and share posters with classmates.

2. Science - Conduct a simulated deep ocean bottom exploration on the playground or other outside location. Have students pretend that they are exploring it for the first time. Have them make quadrats using meter sticks taped together to form square quadrats. Hula hoops work well as circular quadrats. Have them draw their entire quadrat and record observations of both living and nonliving components on the Student Data Sheet using a transect, or line across the quadrat.

3. Language Arts and Science - Read a book or research the Internet for information about deep sea life.

4. Language Arts - Write your own captain's log about diving to the depths of the ocean and returning to the surface.

Resources

www.oceanexplorer.noaa.gov

Ocean Exploration Information Sheet – Attached

www.ohia.com/ohia/roadshows/ocean/ocean/ocean.htm

www.coralreefalliance.org/aboutcoralreefs

"Coral Reef Information" links

National Science Education Standards

Content Standard A: Science As Inquiry

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

Content Standard G: History and Nature of Science

- Science as a human endeavor
- Nature of Science
- History of Science

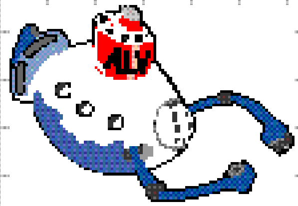
Student Data Sheet

(Use with Science Extension 2)

Quadrat No.______
Transect No.______

Animals		**Plants**		**Burrows & Mounds**		
Description	No.	Description	No.	Description	No.	Soil Description

Many scientists, including those that use the ALVIN to explore the deep ocean, use quadrats as tools for quantifying organisms. Do you think this is a good method? Why or why not?



Activity

Why Do We Explore?!?!?!
(Adapted from NASA's Destination to Mars)

About This Lesson

Students will work in small teams, each of which will be given a different reason why humans explore. Each team will select one reason for exploring as a group and will become experts on their chosen reason. The team will add a letter and summary sentence to an EXPLORE poster using their reason for exploration. With all the reasons on the poster, the word EXPLORE will be complete. Students will be using the skills of working in cooperative learning teams, reading, summarizing, paraphrasing, and creating a sentence that will best represent their reason for exploration. Students will also be illustrating and copying other teams' sentences so that each student will have a small copy of the large classroom poster for reference or extension purposes.

Objectives

Students will:

- Review the seven traditional reasons why people explore.
- Write a summary of their reason why humans explore.
- Illustrate their exploration summaries.
- Relate the reasons for exploration to the Deep East Voyage of Discovery.

Background

Students do not always realize that the steps in future exploration are built on a tradition of exploration that is as old as humans. This lesson is intended to introduce the concept of exploration through the seven traditional reasons that express why humans have always been explorers. Social scientists know that everyone, no matter how young or old, is constantly exploring the world and how it works. Deep sea technologies have opened an entire new world for us to explore. It is essential that students understand the traditional reasons why humans are reaching beyond the land on which we live to the deep ocean and why continued exploration is important. Students will be able to make informed decisions regarding exploration and the future of our planet only if they understand that our future as explorers holds its foundations in our past and in our very nature as human beings.

Seven Reasons for Exploring

1. People are curious.
2. Exploration looks ahead, not behind.
3. Leaders in exploration are leaders in the world.
4. New places can be helpful because they have raw materials and natural resources.
5. Exploration helps us understand our place in the universe.
6. Exploration opens up new places.
7. Humans love adventure and exploring new places is the best kind of adventure.

Additional Resources

NOAA Deep East Voyage of Discovery
www.oceanexplorer.noaa.gov/explorations/deepeast01/deepeast01.html

History of ALVIN
http://www.marine.whoi.edu/ships/alvin/alvin_history/alvin_history.htm

Voyage to the Deep
http://www.ocean.udel.edu/deepsea/level-1/creature/creature.html

Extreme Science
http://www.extremescience.com/deepcreat5.htm
Deep Sea Pages
www.bmi.net/yancey/

Materials

- ❒ One large piece of butcher paper or art paper
- ❒ One set of large cut letters E-X-P-L-O-R-E
- ❒ Tall sentence strips or sturdy pieces of paper cut to fit the poster (one per team)
- ❒ E-X-P-L-O-R-E paragraphs, one per group
- ❒ Tape
- ❒ Pencils
- ❒ Markers
- ❒ Paper
- ❒ Student Sheet, *Why Do We Explore?* (1 per group of 3-4 students)

Procedure

Advance Preparation

1. Read background and additional resource materials as necessary.
2. Make the poster by placing letters vertically on large butcher paper, spelling E-X-P-L-O-R-E. Laminate if possible for reuse.
3. Duplicate the handouts.
4. Prepare for seven teams.
5. Divide students into seven teams.

Classroom Procedure

1. Explain to the students that all humans are explorers, including each one of them.
2. Give each team a set of materials and the handout for their team.
3. Read the introduction on the top of the Student Sheet – *Why Do We Explore?* to the students.
4. Have the students read about the traditional reason for exploration given to their team.
5. Have the students, as a group, write a sentence that best explains or summarizes their team's reason for exploring. The team's sentence must begin with the letter assigned to the team.
6. Ask each team to brainstorm to decide on and draw an illustration for their sentence.
7. Have each team copy their sentence and illustration onto a sentence strip.
8. Instruct each member of the team to copy the team's sentence and illustration on the paper provided so that each student has a copy.
9. The members of the team will place their sentence strip on the large poster and explain their sentence and illustration to the rest of the class.
10. Each student will copy the other teams' sentences onto their own paper so that they each will have a mini-poster when the exercise is completed. The mini-posters can be used for closure, extensions, writing prompts, review sheets for testing, and/or making other connections to deep ocean exploration.
11. Lead a discussion that connects the historical reasons for exploration with the desire to explore the deep ocean, using robots and submarines.

Student Sheet

"Why Do We Explore?"

Whether we know it or not, we are natural-born explorers. There are many reasons why we explore. From birth we learn about life and how it works by exploring. No one can be satisfied for very long without exploring. Whether you are talking to someone next to you or looking around the room, you are exploring!

DIRECTIONS:

1. You and your partners are constructing the EXPLORE poster on the wall.
2. Each team has a paragraph indicating one of the seven different reasons why humans explore.
3. At the beginning of the paragraph there is a letter designated for your team. You will use this letter to start a sentence that summarizes your team's reason for exploring.
4. Think of a sentence that describes the ideas from your paragraph. It has to begin with the letter listed on the top of your paragraph. Write the sentence on the sentence strip.
5. Make an illustration to go with your sentence and put it on the sentence strip. Be creative in your use of color.
6. Each student should make a copy of your team's sentence and illustration on the paper provided.
7. Place your team's sentence and illustration on the poster and discuss them with the class.
8. Copy each team's sentence and illustration as they, in turn, add them to the poster.

Your team has the letter "E"

People are curious about everything. We learn something new every day. If you get bored, you automatically look for something to do. That is the way we are. We like to learn new things. We also like to understand things and how they work. From the time you were born, you have been finding out how things work by exploring them. Curiosity makes us Explorers.

Your team has the letter "X"

Exploration looks ahead, not behind. We do not want to be stuck in the past. We want to move ahead. Exploration gives us the sense that anything is possible. Exploration leads to knowledge and understanding, and that means you make the world a better place as you explore. People have always tried to leave the world a better place for future generations. Exploration is one way we can do that. It is a gift that people of the past give people of the future. (You may use X or some other letter to start your sentence.)

Your team has the letter "P"

Leaders in deep ocean exploration are leaders in the world. The countries that join together to go to the deep ocean will find new ways of working together and sharing their successes. Working together on major projects in the deep ocean environment will help make nations on Earth more peaceful. Anytime you have to work with others, you learn about them and yourself. Working together with common goals helps people understand each other. It is very hard to go to war with people you understand. Working together also makes us more creative.

Your team has the letter "L"

New places can be helpful to us because they have raw materials and natural resources. If we are going to explore the deep ocean, it can help our economy. Deep ocean exploration creates jobs and technology that make our world better. The deep ocean might have products and materials that are not available on land. We could also look for new; cleaner energy sources in the deep ocean that might help protect our environment.

YOUR TEAM HAS THE LETTER "O"

Exploration helps us understand our place in the universe. What might we find out about the deep ocean that helps us better understand life on land? If there are as yet undiscovered species, what can we learn from them? What useful products might they yield? Might living under the ocean become necessary at some time in the future? What we find in the deep ocean could be the greatest discovery of all time.

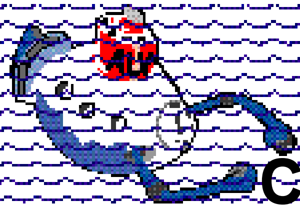
YOUR TEAM HAS THE LETTER "R"

Exploration opens up new places. Our country was once called the "New World" because the people of Europe discovered it when they thought only an ocean existed here. Europeans moved to the "New World," called it America, and we became our own country. We know no new lands exist on Earth to be discovered, so we look to the deep ocean.

YOUR TEAM HAS THE LETTER "E"

We love adventure and when we explore new places, it is the best kind of adventure. Landing on the floor of the deep ocean in a video game is not nearly as exciting as going there in person. Americans love adventure. From the time of the first colonies in America, we have spread across this great land and have loved the fun of discovering new things. We have landed on our own Moon and sent spacecraft to the far reaches of the solar system. When humans explore, we make the universe our classroom for learning.

Adapted from:
Destination: Mars 10/97 NASA JSC



Coral Mania

Focus
George's Bank

Grade Level
5-6

Focus Question
Why are corals able to colonize a deep sea area like George's Bank where light does not reach?

Learning Objectives
Students will learn about the corals that live in the deep sea environment and why they are able to colonize this habitat.

Adaptations for Deaf Students
Vocabulary:
- Pre-teach all vocabulary.
- Add the following: photosynthesis, energy, colonization, and skeleton.

Activity 1
- For Step 6, have the students as a class write a paragraph about the structure and function of a coral polyp. Each student should generate at least one sentence.

Materials
Activity #1 - Internet and Drawing Activity
- ❒ Audio/visual media of living coral – clips from a video
- ❒ Gulf of Maine Poster (map) (REQUEST IN ADVANCE) Maine Coastal Program, State Planning Office, 184 State Street, Augusta ME 04333 (207)287-3261
- ❒ Several samples of corals – any variety (These should only consist of those collected on a beach after animals have died or those purchased from an aquarium shop that sells no wild-collected animals.)

Activity #2 – The Edible Coral Polyp
For each student:
- ❒ 1/2 oz. white baking chocolate, candiquik mix, or other hard candy coating
- ❒ 1 large marshmallow (or section of banana or a strawberry)
- ❒ Toothpicks (for punching holes in marshmallows ONLY) - one per student
- ❒ 6 2-inch strips of red licorice (either whip or regular cut into thin strips)
- ❒ One teaspoon blue, red or green sprinkles

For each group of 4-5 students:
- ❒ Heat source (hot plate or microwave)
- ❒ Pan for candy coating
- ❒ One paper plate

Science Extension – Moraine Formation
- ❒ "Glaciers" (Prepared ahead by freezing a two-inch layer of water in a 5" x 9" loaf pan)
- ❒ Rubbermaid dishpan with ends labeled "Landward" and "Seaward"
- ❒ Substrate materials (sand and gravel, 2 liters of each)

Audio/Visual Equipment
- ❒ VCR

Teaching Time

Two to three periods of 45 minutes each

Seating Arrangement

Groups of 4 students

Maximum Number of Students

30 students

Key Words

Coral	Substrate
Octocorals	Coral Reef
Polyp	Tentacles
Symbiosis	Glacier
Symbiont	Moraine (terminal moraine)
Zooxanthellae	

Background Information

Read "Coral Reefs: A Fact Sheet"
Used with permission from Coral Reefs: *An English Compilation of Activities for Middle School Students*. By Dr. Sharon Walker, Amanda Newton, and Dr. Alida Ortiz. 1997. USEPA NCEPI.
Original source: *Coral Forest Teacher's Guide.* Coral Forest, 400 Montgomery Street, Suite 1040, San Francisco, CA 94104

The primary organisms of interest at the George's Bank location are assemblages of deep-water octocorals never before studied in depth. Virtually nothing is known about their reproductive biology and feeding habits. These corals are relatives of shallow water reef-forming corals but live in deep water habitats where photosynthesis cannot occur. Most shallow water corals have photosynthetic symbionts (a type of algae called zooxanthellae) that live inside their outer calcium carbonate skeleton and provide food for the polyps. Since no light penetrates to the depths where these deep sea corals exist, this is not an option for them as a means of obtaining nutrition. What these corals use as their source of energy is just one of the many questions which scientists hope to be able to begin to answer from data gathered from the Deep East 2001 Voyage of Discovery.

Another difference between shallow reef corals and deep corals is that shallow corals build the reef, whereas the deep corals need a hard bottom on which to settle. Therefore, a determining factor in the colonization of this area by these corals lies in the geological history of George's Bank. While there is not complete concensus among geologists regarding this, it is generally accepted that this formation represents a terminal moraine (the pile of sand, gravel and rocks left at the leading edge of a glacier when it recedes) formed by seaward glacial movement. Such activity would have left this area with much more hard substrate, in the form of rocks and boulders, than may otherwise exist. Larval forms of corals require hard substrates for colonization.

In Activity 1, students use the Internet to gather information about the general structure of coral polyps and the functions of each part of a polyp.

In Activity 2, students construct an edible polyp.

In Activity 3, students use near realtime photographic images from the Deep East Expedition posted daily by the Web Coordinator to learn more about size and distribution of the octocorals in the Canyons of George's Bank.

LEARNING PROCEDURE

Activity 1 – Internet and Drawing Activity

1. Have students visit the following web site and learn about corals. www.enchantedlearning.com/subjects/invertebrates/cora/Coralprintout.html
2. Have students draw and label their polyp and include information about the functions of each part of the polyp.
3. Discuss zooxanthellae and their function for shallow water corals and why the means of obtaining nutrition would have to be different for deep water corals.
4. Using the Gulf of Maine poster, talk about the area that will be visited by the Deep East Voyage of Discovery. This is one area where the deep sea octocorals exist.
5. Allow students to observe samples of corals. Remind them that what they are seeing is only the outer calcium carbonate skeleton, not the coral animal itself.
6. Have students write a paragraph about the structure and function of a coral polyp.

Activity 2 – The Edible Coral Polyp – see attached

Used with permission from Coral Reefs: *An English Compilation of Activities for Middle School Students*. By Dr. Sharon Walker, Amanda Newton, and Dr. Alida Ortiz. 1997. USEPA NCEPI. Original source: *Coral Forest Teacher's Guide*. Coral Forest, 400 Montgomery Street, Suite 1040, San Francisco, CA 94104

Activity 3 – Investigation of Corals Actually Being Sampled by ALVIN at George's Bank

1. Students visit the Deep East web site and obtain images from ALVIN dives posted daily by the Web Coordinator on the Deep East Voyage of Discovery.
   www.oceanexplorer.noaa.gov/deepeast01/deepeast01/html
2. Students visit the Task Force Atlantis web site and go to links to learn more and see pictures of these deep sea octocorals.
   www.atlantisforce.org

THE BRIDGE CONNECTION

www.vims.edu/bridge/data.html

Choose Ship Mates for a great site with data from the Gulf of Maine and an explanation of what it means.

THE "ME" CONNECTION

Have students revisit
www.coralreefalliance.org/aboutcoralreefs
and go to the links under "Coral Reef Information" to learn about the great importance of coral reefs to humans. Discuss whether any students have relatives who have been or could be helped by some of the medicines already discovered or being researched.

CONNECTIONS TO OTHER SUBJECTS

1. Language Arts – Evaluate students' paragraphs about the structure and function of a coral polyp.

2. Language Arts – Evaluate students' understanding of new vocabulary.

EVALUATION

Evaluate students' coral polyp paragraphs and drawings for completeness and accuracy.

EXTENSIONS

1. Math and Science - How big are these octocorals and how are they distributed?

a. Each day during Leg One of the Deep East Expedition, students visit the Web site

to obtain images posted there by the Web Coordinator.
b. Laser scaling can be used to estimate size.
c. If sufficient information is available about the size of the field in images, general distribution of the octocorals can be estimated.

2. Science - How does a moraine form?
a. Refer again to the poster of the Gulf of Maine and George's Bank. Discuss moraine formation by glaciers and show the moraine on the poster (George's Bank).
b. Give each group of students a Rubbermaid dishpan with about 5 cm of mixed substrate and about 7 cm of water overlying it.
c. Explain that each group is going to receive a "glacier" (piece of ice) with which to simulate glacial movement across the substrate in the container.
d. Remove "glaciers" from freezer or cooler and provide one to each group
e. Instruct each group to move their "glacier" slowly across the substrate.
f. Tell them to observe the leading edge.
g. Have each student write a paragraph about what occurred during the activity and draw a before and after picture of how they think their substrate looked from a side view.
h. Relate this process to the geology of the George's Bank study area. (Use the www.atlantisforce.org web site.)

3. Science - Allow students to go to the WebQuest Coral Reef project Web site. It contains a clever game charging the students with the responsibility to protect a coral reef. http://manteno.k12.il.us/drussert/WebQuests/KeithFinlayson/Coral%20Reef%20Project.html

4. Science - Go to the Waikiki Aquarium Research Web Site (www.mic.hawaii.edu/aquarium/research/) and click on "Research" under "Corals." Depending on the time in Hawaii, there is a nice live cam view of coral polyps. There are also a number of nice links to other sites about corals and protection programs.

5. Math - Word problems (for example, multiply numbers of tentacles in a colony of octocorals with a certain number of polyps.)

6. Language Arts – Using the information from Web sites (both in the lesson and extensions) and what has been learned about the deep sea octocorals, have students write letters to legislators regarding having this type of coral assemblage added to a protection program.

7. Language Arts - Using information from Web sites and links, have students make a list of ten things that they can do to protect corals.

Resources

www.oceanexplorer.noaa.gov
(Click on Explorations, then Deep East for background information.)
www.atlantisforce.org/nonamecanyon.html
www.atlantisforce.org/gombankmap.html
www.terryparker.duval.k12.fl.us/reef.htm

National Science Education Standards

Content Standard C: Life Science
- Structure and function in living systems
- Diversity and adaptations of organisms

Content Standard D: Earth and Space Science
- Structure of the Earth system

What's New?

Focus
Hudson Canyon

Grade Level
5-6

Focus Question
What kinds of organisms live in the habitats of the walls of Hudson Canyon?

Learning Objectives
Students will learn about the biodiversity in Hudson Canyon.

Students will learn about similarities and differences between related organisms.

Adaptations for Deaf Students
Vocabulary:

- Pre-teach vocabulary.
- Additional vocabulary: organisms, opportunistic, and potential.

Seating Arrangements

- Students can work in teams of two rather than four so that all can have a hands-on experience during the lesson or the entire class can work as one team.

Materials
For each pair of students:

- ❒ One live earthworm (Red wigglers work well for classroom use and can be obtained at a bait shop locally or by ordering from a science supply company.)
- ❒ 9" x 12" tray for experimenting with earthworms
- ❒ One sheet of black construction paper
- ❒ One sheet of white paper
- ❒ One square of window screen – 10 cm x 10 cm
- ❒ Paper towels
- ❒ Water for moistening a paper towel
- ❒ Magnifiers
- ❒ Metric ruler
- ❒ Flashlight
- ❒ Student Data Table

Audio / Visual Equipment
N / A

Teaching Time
Two periods of 45 minutes each

Seating Arrangement
Groups of four students

Maximum Number of Students
30 students

Key Words
Biodiversity
Benthic
Polychaete worm
Oligochaete worm
Continental shelf
Continental break

Background Information
Hudson Submarine Canyon is an ancient extension of the Hudson River Valley, through which the Hudson River flowed during the last Ice Age. It extends over 400 nautical miles seaward from the New York-New Jersey Harbor, across the continental shelf to the continental

break. Due to its geology and the fact that it is a conduit for sediments, including pollutants between the land and the deep ocean, Hudson Canyon is particularly susceptible to movement of materials downcanyon and may concentrate pollutants and other materials in the Canyon. Additionally, the 106-mile Deepwater Dumpsite (DWD-106) is located adjacent to the Canyon. For many years, it received the world's largest discharge of municipal sewage sludge to the deep ocean. This was halted in 1992 after investigations using the submersible ALVIN revealed chemical increases and biological changes not expected when the dumping was originally permitted.

These investigations also revealed great biodiversity, indicating that further exploration has the potential for the discovery of unusual and previously undiscovered deep-sea creatures. One of the groups of organisms that are likely to be present in large numbers and different types are polychaete worms. These worms are members of the Phylum Annelida, also known as the segmented worms, and have characteristics in common with their terrestrial "cousins," the earthworms (Oligochaetes). There are thousands of species of polychaetes known to inhabit both shallow and deep water marine habitats. They are also known to be opportunistic colonizers, often inhabiting areas not used extensively by other organisms.

Learning Procedure

Activity 1 – Polychaetes and Oligochaetes – What's the Difference?

1. Ask the students what they know about earthworms and record their answers on the board or a flip chart.
2. Tell the students that they are going to look at some earthworms and try to learn some new things about them.
3. Give each pair of students an earthworm on a tray and a box with the other materials.
4. Ask them to observe their earthworm and draw it, including all of the characteristics that they can see. Have them use magnifiers. Have the students measure the length of their worm and record the measurement on their drawing. Remind them that earthworms are living creatures and that they should handle them carefully to prevent injuring them while using their earthworms in experiments.
5. Tell them that they are going to use their materials to learn more about their earthworms.
6. Ask the question "How can we find out if earthworms prefer light or dark?"
7. Instruct students to fold the sheet of black construction paper in half lengthwise and set it on their table to make a tent.
8. Students will stand next to the tent and hold the flashlight 15 cm from the table top so that it shines down on one end of the tent and place the earthworm in the light beam.
9. Students will observe their earthworm for 3-4 minutes.
10. Students will record their observations on the Student Data Table.
11. Students will repeat the experiment four more times.
12. Ask the question "How can we find out whether earthworms prefer rough or smooth surfaces?"
13. Instruct students to place the window screen and piece of white paper on their

table, overlapping slightly, and to place the earthworm where the edges meet.

14. Students will observe their earthworm for 3-4 minutes.
15. Students will record their observations on the Student Data Table.
16. Students will repeat the experiment four more times.
17. Ask the question "How can we find out whether earthworms prefer a moist or dry environment?"
18. Instruct students to moisten one paper towel slightly and to place it and a dry paper towel next to each other on their table, overlapping slightly.
19. Students will place their earthworm where the two paper towels meet.
20. Students will observe their earthworm for 3-4 minutes.
21. Students will record their observations on the Student Data Table.
22. Students will repeat the experiment four more times.
23. Have the students write a paragraph about the three experiments and their results.
24. Explain earthworm taxonomy to the students. Tell them that we are now going to learn about some related segmented worms, the polychaetes, that live in the deep ocean in the area being explored by the ALVIN on the Deep East Voyage of Discovery.

Activity 2 – Polychaetes From the Deep!

1. Have students go to the Deep East Web site. www.oceanexplorer.noaa.gov/explorations/deepeast01/deepeast01.html
2. Have students print out copies of photos that have been posted from the dives accomplished on that day or prior.
3. As a group, discuss what is seen in the pictures. (Scientists are expecting to find lots of polychaete worm tubes and worms!) Discuss the fact that polychaetes are the ocean "cousins" of the terrestrial earthworms. You should be able to see the segments as well as the hairs and bristles on each one. These hairs and bristles give them their nickname, "bristleworms."
4. Have students use various resources, such as encyclopedias, marine science books, and the Internet, to learn more about these amazing creatures.
5. Have students prepare a one-page report with an illustration about polychates.

THE BRIDGE CONDNECTION

www.vims.edu/bridge/elementary.html

Click on 5th or 6th grade. Go to Ocean Planet: Interdisciplinary Marine Science Activities and choose Ocean Planet from the list.

THE "ME" CONNECTION

www.vims.edu/bridge/elementary.html

Click on 5th or 6th grade. Go to Ocean Planet: Interdisciplinary Marine Science Activities and choose Ocean Planet from the list. Once there, choose Ocean Market. This is a good activity and has links to others. Exploration and discovery of new species yields much information of use to mankind. This includes things such as new medicines, information about how organisms change over time, both in the ocean and on land, and the potential for discovering new ways that organisms process food for energy.

Connections to Other Subjects

Mathematics, Language Arts

Evaluation

1. Evaluate student drawings and written reports about earthworms.
2. Have students construct a Venn diagram to identify similarities and differences between earthworms (oligochaetes) and polychaetes. Use characteristics such as segments, bristles, and shape. Either of the designs below could be used, depending upon the knowledge and level of thinking skills possessed by students. There are also many other combinations of these characteristics that could be used.
3. Evaluate student reports about polychaetes.
4. Evaluate accuracy of worm measurements.

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Extensions

Science - Learn more about the man who is so interested in these deep sea organisms, Dr. Fred Grassle, using the Ocean Explorer web site.

Language Arts - Have students write a paragraph about why they would or would not like to be a scientist who studies worms or other creatures that live in the deep ocean.

Resouces

www.oceanexplorer.noaa.gov
www.nrm.se/ev/research/oligo.html.en
www.inhs.uiuc.edu/cbd/main/geninfo/oligo.html
www.kwic.com/~pagodavista/schoolhouse/species/insects/worms.htm
www.ocean.udel.edu/deepsea/level1/creature/creature. html

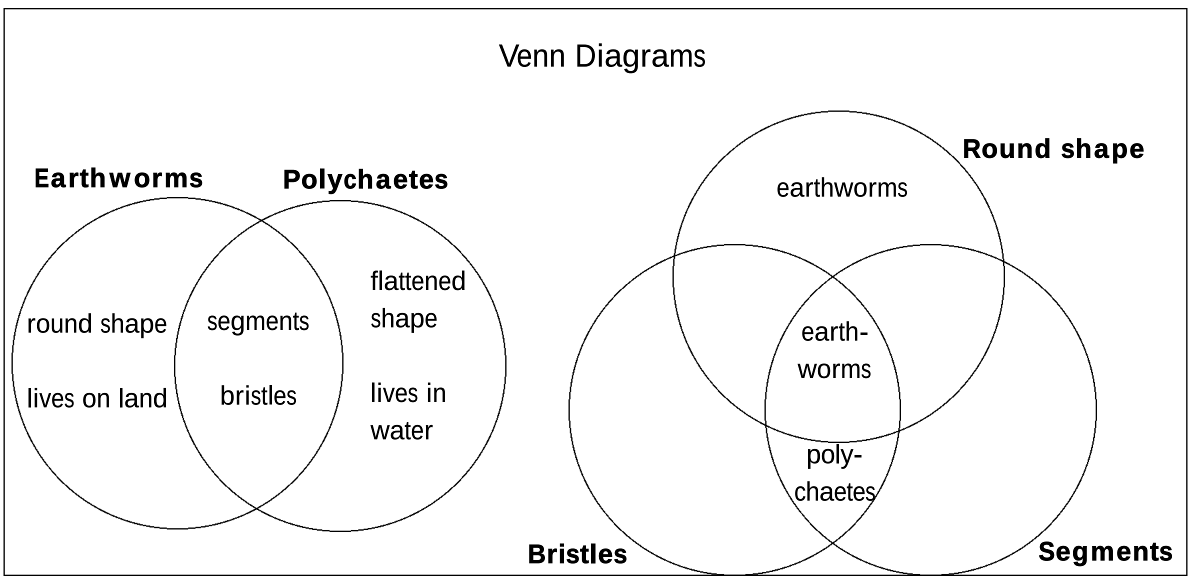
National Science Education Standards

Content Standard A: Science as Inquiry

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

Content Standard C: Life Science

- Diversity and adaptations of organisms

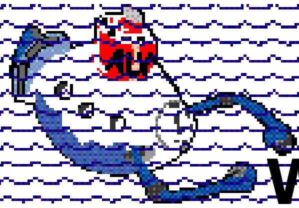


Student Data Table
(Use with Activity #1)

Polychaetes and Oligochaetes – What's the Difference?

Light or Dark???	Trial #1	Trial #2	Trial #3	Trial #4	Trial #5
Prefers light					
Prefers dark					
Rough or Smooth???	Trial #1	Trial #2	Trial #3	Trial #4	Trial #5
Prefers rough					
Prefers smooth					
Moist or Dry???	Trial #1	Trial #2	Trial #3	Trial #4	Trial #5
Prefers moist					
Prefers dry					

NOTES/THOUGHTS/INSPIRATIONS



What on Earth is That, and How Can I Get One?

Focus
Blake's Ridge

Grade Level
5-6

Focus Question
What kinds of technology are used by the ALVIN to explore and make new discoveries?

Learning Objectives
Students will understand various sampling technologies used by submersibles in ocean exploration.

Adaptations for Deaf Students
Vocabulary:

- Additional vocabulary words to include are conductivity and substrate.

Background Section:

- The teacher should explain the purpose of CTD measurements during the Deep East Voyage of Discovery and ocean research in general, as this will be new information for most students.

Materials (per group of 4 students)
For Coring Activity:

- ❐ Two 8-foot clear polycarbonate tube lamp guards (fluorescent bulb covers – these available at hardware stores for about $3.00) cut into 16 12-inch sections. Use one section per group.
- ❐ One pair of scissors or a razor knife to cut the bulb covers (This is performed by the teachers).
- ❐ One 2-quart or 2-liter translucent round pitcher (opening as large as container diameter)
- ❐ Teacher-made substrate for each group that consists of a mixture of the following: 1 liter of beach sand or play sand, 1 liter of water, 20 various kinds of small shells (3 cm and smaller)
- ❐ One tray, at least 9"x12", tray for observing core samples
- ❐ Colored tape or masking tape to divide the bottom of the tray into four rectangular sections of equal size
- ❐ Sediment sieves with 1/2 cm, 1/4 cm and 1 cm mesh (optional)

For Salinity/Conductivity Activity:

- ❐ Simple electric circuit setup (one bulb, four wires, two batteries) See Learning Procedures for setup specifics.
- ❐ One cup of water
- ❐ 50g salt
- ❐ One teaspoon
- ❐ Student Data Table

Teaching Time
Two periods of 45 minutes each

Seating Arrangement
Groups of 4 students

Maximum Number of Students
30 students

Key Words

Organism
Technology
Sediment
Core sampler
Water quality

Background Information

Ocean exploration has changed drastically in recent years. Improvements in diving equipment, submersibles, still and video cameras, and advancements in computer technology have revolutionized the field of ocean exploration. However, even with all of these advances, very little of the Earth's oceans have been explored (only about 5%). The Deep East Voyage of Discovery is an effort to further explore three areas along the North American continental shelf break that have had very limited exploration to date, all of which have the potential to yield amazing new information, including new species and new energy sources. The three areas are the George's Bank in the Gulf of Maine, the Hudson Canyon off New York, and Blake's Ridge off the southeastern United States. It should be stressed that this voyage is for the purposes of exploration, to document what scientists find there, and to generate further questions about the organisms and their habitats. This is true scientific inquiry.

The vessels to be used for this voyage of exploration are the research vessel *Atlantis* and the submersible ALVIN, which are owned and operated by the Woods Hole Oceanographic Institute. The submersible ALVIN, which carries a pilot and two scientists, will be deployed for a series of dives at each of the three sites. Sampling will consist of temperature and conductivity by depth using a CTD (conductivity/temperature/depth) probe fixed to the ALVIN to look at temperature and conductivity by depth, tube and box cores, suction, grab and claw samples taken using the mechanical arms, imagery using video and still cameras, and human documentation using logs. For the purposes of this lesson, CTD data and core sampling will be targeted.

Learning Procedures

1. Go to the Deep East and ALVIN Web sites (www.oceanexplorer.noaa.gov/explorations/deepeast01/deepeast01.html and www.marine.whoi.edu/ships/alvin/alvin_history/alvin_history.htm) and have a discussion of ocean exploration, including the Deep East Voyage of Discovery using the research vessel *Atlantis* and the ALVIN. What would you want to know about a new site being explored for the first time and how would you collect your information? How does ALVIN collect samples? Chapter one in *Off to Sea* (see Resource section) has a good description of the *Atlantis*, the ALVIN, and their capabilities.

2. To collect core samples of different sediments using the bulb covers:
   a. Tell students that they will be collecting samples similar to the way ALVIN does.
   b. Give each group of four students one 12-inch section of a fluorescent light bulb cover and an empty pitcher, some sand, water, and shells.
   c. Have students measure 1 liter of sand and 1 liter of water. Pour the sand in the pitcher first. Mix shells with sand. Add water and mix all ingredients together.

d. Challenge each group to determine how to use their bulb cover to get a sample of the substrate out of the pitcher.

e. After students figure out that they need to put their hand on one end, take 4 samples of substrate to put in each section of the tray. Notice suction felt on hand.

f. Have students observe cores for likeness and differences. Relate this to taking cores on the ocean floor. Not all samples are the same, even in the same area.

g. Discuss how this demonstrates the way that the coring of bottom sediments is accomplished by ALVIN.

h. Have students write a paragraph and illustration (journal entry) about how they made their cores (what was successful and what was not) and what they found in their cores.

i. If time permits, allow students to experiment with many different sizes and shapes of containers as their "core sampler" to see which works best. Discuss with students the advantage of using a clear core to see vertical layers in the sediment.

3. Salinity/Conductivity

CTD Data from ALVIN – ALVIN will be able to provide, on a daily basis, salinity/conductivity-temperature-depth.

a. Students will make a simple electric circuit using one bulb, four wires and two batteries.

b. First, use one cup of water. Put the two non-insulated wire ends into the water and observe. Record your results on the Student Data Table. Add one teaspoon of salt at a time and record results on the Student Data Table.

c. Have students determine the amount of salt necessary to light up the bulb and discuss what causes the bulb to light. As salt is added to water, the salt molecules break apart, or dissociate, into ions of sodium, which is positively charged, and chloride, which is negatively charged.These charged particles in between molecules of water increase its ability to conduct an electric current.

d. Record data in the Student Data Table.

e. Explain that this is how that a CTD determines the salinity of water. It measures how conductive the water is. The more electrical current that is conducted by the water, the higher its conductivity.

f. CTD data – Prepare ahead one large graph (flip chart) of temperature vs. depth and one for salinity vs. depth and post them at the front of the classroom.

g. Give each group four data sets (temperature and salinity from a given depth) from a dive to add to the class graphs.

h. Have each student in each group add one point to the class graph. Discuss how the variables are related.

The BRIDGE Connection

http://www.vims.edu/bridge/data.html

Choose Ship Mates for a great site with data from the Gulf of Maine, Hudson Canyon, and Blake's Ridge and an explanation of what it means.

The "Me" Connection

www.vims.edu/bridge/elementary.html

Click on 5th or 6th grade. Go to Ocean Planet: Interdisciplinary Marine Science Activities and choose Ocean Planet from the list. Once there, choose Sea Secrets and Sea Connections.

Chapter 5 in *Dive to the Deep Ocean*. (See Resource section.)

Have a general discussion of discoveries at hydrothermal vents in the Pacific Ocean and the potential for new discoveries at the areas being explored during the Deep East Voyage of Discovery. While the organisms that are found at each of these habitats are different due to the very different temperatures, the types of potential beneficial discoveries are similar.

The ocean has long been known to be a source of many products important to humans, as well as a source of information regarding the events that have formed the Earth and determined its weather. Exploration of deep-sea habitats never studied before with submersibles has the potential to yield even greater discoveries of great benefit to mankind. Just in the past 20 years, over 300 new species have been identified from deep-sea habitats. Many of these species use chemosynthesis rather than photosynthesis as their source of energy and use bacteria rather than enzymes to digest their food.

Other potentially beneficial discoveries include things such as new medicines, food products, ores, mineral salts, products such as algin used as thickeners, and new geologic discoveries that help us better understand the formation of continents and oceans. Use the Ocean Planet Web site referenced in the Resource section. There is much more detail regarding discoveries that have been made near thydrothermal vents and cold seeps.

Connections to Other Subjects

Language Arts – Evaluate journal entry about core samples

Mathematics – Mixing and measurement in salinity activity

Mathematics – Graphing (temperature/depth and salinity/depth)

Mathematics – Measurement of sand, water, and shells in Core Sample Activity.

Evaluation

Evaluate the paragraph on the coring activity and the illustration for accurate content and effort.

Evaluate group temperature/salinity graph for accuracy and effort.

Science Extensions

1. Sorting, sizing, and identification of "organisms" in core samples. Use Brock scopes, magnifiers, and field guides.
2. Use sieves to look at grain sizes of dry sand.
3. ALVIN Simulation – Discuss how ALVIN moves to collect samples using its grab arm. Have students simulate being ALVIN by lying on their stomachs (on the grass outside or carpet inside) and provide certain "specimens" (pine cones, etc.) to be "collected" without using their hands (they will need to use some type of "claw.")
4. Visit http://library.thinkquest.org/18828/data/sc_8.html

and learn more about Dr. Cindy Van Dover, Principal Investigator for the Blake's Ridge leg of the Deep East Voyage of Discovery. She is also a certified ALVIN pilot.

5. Try collecting samples using the fluorescent bulb tube in different places on the playground. Observe similarities and differences to the core sampling conducted in the classroom.
6. Have students find out about air pressure and how this affected their ability to collect a core sample. Try using a straw to pick up and move a liquid. Relate this to collecting core samples.

Resources

www.oceanexplorer.noaa.gov

Click on Explorations, then Deep East for background information.

www.whoi.edu/science/science.html

www.vims.edu/bridge/elementary.html

Choose Ocean Planet, then Ocean Market, Sea -Connections or Sea Secrets to learn more about things that we already get from the ocean and potential new products and discoveries.

Kovacs, Deborah. *Dive to the Deep Ocean: Voyages of Exploration and Discovery*. 2000. Raintree Steck-Vaughn Publishers.

Kovacs, Deborah. *Off to Sea: An Inside Look at a Research Cruise*. 2000. Raintree Steck-Vaughn Publishers.

National Science Education Standards

Content Standard A: Science as Inquiry

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

Content Standard C: Life Science

- Populations and ecosystems
- Diversity and ecosystems of organisms

Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

Student Data Table

(Use with Learning Procedure #3)

Salinity / Conductivity

# of teaspoons of Salt	Description of Light Bulb's Appearance