Introduction

When you visit *Extreme Deep: Mission to the Abyss*, you'll come face-to-face with the last frontier-the deep sea.

You'll meet *Alvin, JASON* and *Remus*, state-of-the-art robotic explorers that will take you on extreme deep adventures. There you'll discover bizarre fish and tour sunken ships. You'll explore lush gardens thriving in the searing heat of underwater hydrothermal vents. Before it's all over, you'll even catch a glimpse of the future.

The theme for this Teacher's Activity Guide is explorations. In the first section, you'll find pre-visit activities that will help you and your students launch local expeditions. Find out what it's like to be an adventurer. Explore the familiar surroundings of your schoolyard or the uncharted territory of nearby fields or forests. Your students are sure to make exciting new discoveries.

In the second section are post-visit activities that will help your students unravel the mysteries of the deep sea. All activities are multidisciplinary and can be integrated easily into your curriculum to enhance and enliven your current lesson plans. In the final section of this guide, you'll find a glossary and resources that may be helpful when planning your adventure.

So gather up your supplies, check your lists and chart your mission to the unknown.

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Explorer Report

OBJECTIVES

Students will discover that...

- explorers rely on tools and technology to successfully complete an expedition.
- explorers and scientists have been using technology for a long time.
- studying the history of scientific explorers shows how difficult it is to make new discoveries and technological breakthroughs.
- science and technology have advanced through contributions of many different people, in different cultures, at different times in history.

SUBJECTS
history, language arts, library science
GRADES
K - 12
CONCEPTS
explorers and expeditions in history; science and technology in society
DURATION
one 30-minute class session to read a story and discuss (Grades K - 3) or to introduce the activity (Grades 4 - 12); two to three 45-minute class sessions for students to present their reports (Grades 4 - 12)

BACKGROUND INFORMATION

Why do people explore? Do they explore because they're curious? Do they explore to find new resources? Do they explore for fame or fortune? Do they explore to learn? The answer depends on the particular explorer.

This activity will introduce your students to explorers of the past. By studying a particular explorer, they'll learn what prompted that person to set off on adventure and what that person learned. After each student shares his or her discoveries with the class, your students should get a sense of what we can learn from the trials and tribulations of "those who have gone before."

Explorer Report

ACTIVITY

Materials
- none

GRADES K - 3

Questions to Begin
- What's an explorer?
- Can you name an explorer?

Procedure
1. Read a book about an explorer to the class. (Ask your librarian for suggestions.) The explorer can be an astronaut, aquanaut, or someone like Captain Robert Falcon Scott who explored Antarctica, or Magellan who discovered a southern route from the Atlantic to the Pacific.
2. Discuss the story using the following questions as a guide.

Questions to Close
- What was the explorer trying to accomplish?
- Did he or she succeed in the goal?
- What tools or equipment did the explorer bring along?
- What was the hardest thing that the explorer had to do? How did he or she rise to the challenge?
- What did the explorer learn as a result of the expedition?

GRADES 4 - 12

Questions to Begin

- How many of you have ever met an explorer?
- How many of you have ever studied explorers of the past?
- Who's your favorite explorer? Where or what did he or she explore?

Procedure

1. Begin with a discussion about the impact explorers have made throughout history.
2. Ask each student to read a book about a famous (or not-so-famous) explorer. The explorer can be an astronaut, aquanaut, or someone like Captain Robert Falcon Scott who explored Antarctica, or Magellan, the Portuguese sailor who discovered a southern route from the Atlantic to the Pacific.
3. The following week, have students begin writing a book report. For additional information they can consult encyclopedias, additional biographies or the Internet.
4. Once the book reports are finished, have students make presentations to the class about what they learned. They should use as many media as possible including music, posters, costumes, etc.

Questions to Close

- What was the main discovery your explorer made?
- Did the discovery have an impact on society? If so, what?
- Do we benefit from the discovery today? If so, how?
- What tools or equipment contributed to the success of the expedition?
- Did the explorer invent any new tools or technology, either before, during or after the expedition? If so, what? What purpose did the invention serve?

Adapted from:
Acerno, Karen. Extension Activity 1, "How do the Research Vessel and Crew Support Research?" In Off To Sea; An inside look at a research cruise; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.

Explorer Dress-up

SUBJECTS
social science
GRADES
K - 6
CONCEPTS
preparing for an expedition
DURATION
two 30- to 45-minute class sessions, plus outside work

OBJECTIVES

Students will discover that...

- explorers need the right clothes and equipment for the job.
- sometimes explorers need to invent the right clothing or equipment.

BACKGROUND INFORMATION

Before you launch an expedition, you'll need to make sure you have the right clothing. All explorers do this. Take an astronaut, for example. An astronaut's suit acts like a portable life-support system that supplies him or her with air. The suit covers the astronaut from head to toe. If an astronaut were to perform a space walk, thrusters would be added to the backpack to help him or her maneuver in space. Also attached to the suit might be a microphone that helps astronauts talk to each other and to Mission Control back on Earth. Without proper attire, an astronaut, or any explorer, probably could not complete the mission.

ACTIVITY

Materials

- pictures of explorers: astronauts, Arctic or Antarctic explorers, mountain climbers, scuba divers, etc.
- miscellaneous clothing and articles found around the house or in thrift stores
- chalkboard and chalk
- paper and pencil

Questions to Begin

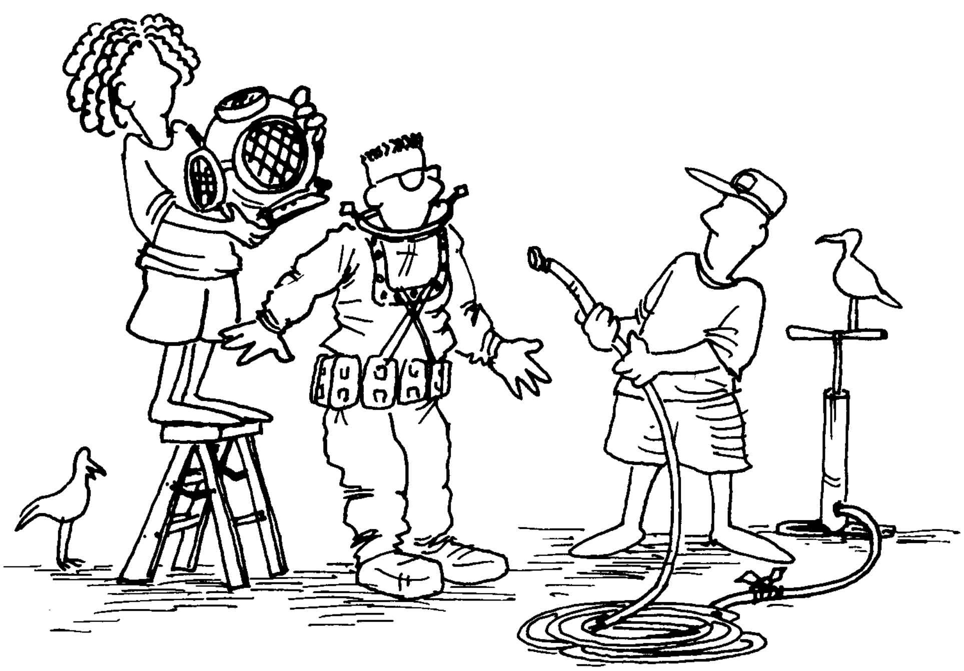
- Share with the class pictures of different explorers. What environment is the person exploring? What is the person wearing? How does the explorer's choice of clothing help him or her?
- Is the person carrying any special equipment? If so, how would the equipment be useful? For example, a mountain climber who explores snowy mountain peaks wears layers of clothing to keep warm, a cap to keep the head warm and spiked boots for walking on snow or ice.

Procedure

1. Brainstorm a list of places the class would like to explore. Encourage students to be creative. Answers such as Jupiter, the bottom of Lake Superior or Earth's upper atmosphere are just as possible as Africa or Siberia. Write responses on the board.
2. Split the class into teams. Have each team of students choose a place from the class list. Their objective is to pull together an outfit that will prepare them to explore the environment of choice. (They may want to enlist the help of parents or friends to pull together a costume.)
3. Set a date for each team to brings its costume to school.
4. One member of each team takes turns acting out the exploration in costume while the rest of the class guesses where they're going.
5. Conclude the activity with a writing assignment. Have each student write about the imaginary adventure for which they prepared.

Questions to Close

- What clothing and equipment did you feel you would need to bring along on your imaginary expedition? Why?
- Why is it important for an explorer to have the right clothes and/or equipment?
- What might happen if an explorer weren't properly prepared?



Adapted from:
Stevens, Betsy, and Amy Pallant. Extension Activity 1, "How do Principles Apply to Submersible Design?" In Dive to the Deep Ocean; Voyages of exploration and discovery; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999

Life Patrol

OBJECTIVES

Students will discover that...

- you can learn a lot about an animal in a short period of time by being a good observer.
- an organism's patterns of behavior are related to its food and shelter, to the physical characteristics of its environment and to the presence of other organisms.

SUBJECTS
life science
GRADES
K - 3
CONCEPTS
observing organisms in their habitats
DURATION
one or two 30-minute class sessions

BACKGROUND INFORMATION

If you were to visit the deep sea to learn about the animals that live there, you'd be forced to learn all you can during a series of quick visits. Something may swim by, or be attracted momentarily to the lights on your submersible. When this happens, you'll have only a few fleeting, but amazing, moments to take in all you can about the creature before it disappears. During these times it's important that you have all your equipment ready and working, that you keep a sharp watch and take detailed notes.

Your students can practice being biologists and hone their observation and studying skills in the safety and convenience of your schoolyard or a nearby park.

ACTIVITY

Materials

- magnifying glasses
- pencil, crayons or other drawing material
- paper
- clipboard or other writing surface
- copies of the Observation Form

Questions to Begin

What kinds of organisms have you seen around the schoolyard?

- Where can you find each?

Procedure

1. Ahead of time, photocopy the Observation Form. Make enough for every 2 or 3 students.
2. Take a class walk to identify animals (ants, worms, robins, sparrows, spiders, sow bugs, etc.) that live around the schoolyard.
3. Make a list of all the animals the class found.
4. Split students into teams. Have each team pick an animal they would like to observe, or you can assign an animal to each.
5. Allow about 15 minutes for the teams to find and observe their organism (be sure to give them boundaries or ask teacher's aides to help keep an eye on students).
6. If your students are in Grades K - 3 have them draw what they see.
   If your students are in Grades 4 - 6, have them fill in the Observation Form.
7. Back in the classroom, have students post their drawings and/or Observation Forms on a bulletin board and tell about their organisms. Make sure they include any interesting discoveries they made.

Questions to Close

- What's the most interesting thing your organism did?
- What does your organism eat? How do you know (what evidence do you have)?
- What kind of shelter does your organism use? How do you know?
- Did your organism interact with other animals or plants?

Adapted from:
Sly, Carolie. Environmental Education Guide: Vol. 1, Grades K-3, 1981-84. Hayward, Ca: Office of the Alameda County Superintendent of Schools, 1981.

Life Patrol Observation Form

Student Name ____

For your organism, fill in the following information.

Size
Color
Number of legs
What covers your animal's body, if anything? (example: feathers, fur, scales, etc.)
Does your animal have teeth? What do they look like?
What other organisms are nearby?
Did your animal interact with another animal? If so, what happened?
Did your animal move? How does your animal move (fly, crawl, swim, walk)?
Is there anything nearby that your animal might use for shelter?
Is there anything nearby that your animal might eat?

Draw your animal here, showing as much detail as possible.

Hundred-Inch Hike

SUBJECTS
life science, language arts
GRADES
3 - 8
CONCEPTS
the scientific method
DURATION
one to two 45-minute class sessions

OBJECTIVES

Students will discover that...

- they can learn about nature by using the scientific method.
- the scientific method consists of Observing something, making a Prediction or hypothesis about why it is the way it is, setting up an Experiment or study, Noting the results and Sharing what you learned (OPENS).
- explorers need to be aware of the difference between observation and inference and to use the scientific method to understand what they're observing.
- hypotheses are valuable, even if they turn out to be untrue, if they lead to fruitful investigations.

BACKGROUND INFORMATION

When scientists first discovered life at hydrothermal vents (places in the deep sea where warm or hot water spews from the seafloor) they made many observations. They also had to be careful about keeping their observations separate from their inferences about what they were seeing. (Inferences are the meanings you derive from your observations.) An erroneous idea could lead a scientist down a dead-end path to understanding. While on expedition, or at any time for that matter, good scientists turn their inferences into hypotheses, then put their ideas to the test. The process they use is called the scientific method.

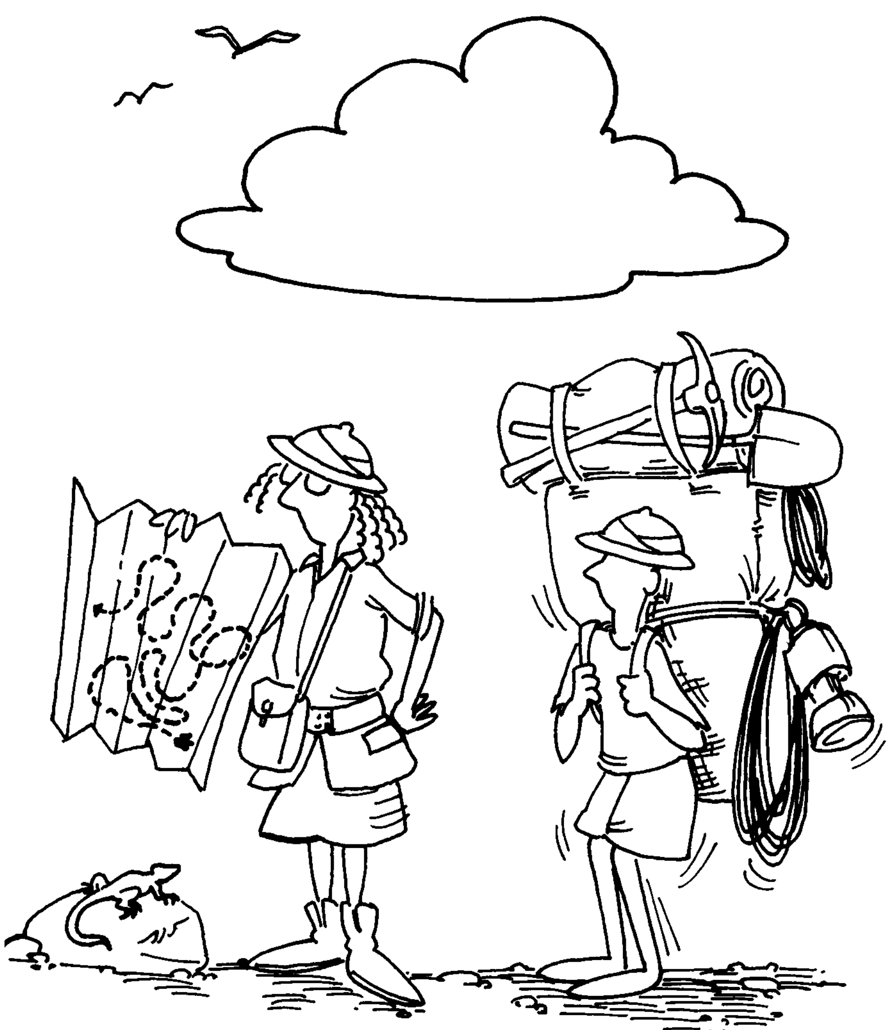
There are five steps to the scientific method: making an Observation, making a Prediction or hypothesis from your observation, setting up an Experiment or study, Noting the results and Sharing what you learned. A good way to remember this is to remember that the scientific method OPENS up a world of knowledge.

The first step of the scientific method is to make an observation. Observations are the exact things you see. For example, if you see a giant tubeworm, your observation would be "Tubeworms are big." Inferences are the meanings you derive from your observations. For example, you might decide the tubeworm you just discovered is big because it eats fish.

The next step is to make a prediction based on your observation. Sometimes the prediction is called a hypothesis. For this example, the prediction is that "Tubeworms eat fish." Scientists have to be sure their prediction is testable. The hypothesis, "Tubeworms eat fish" is testable because you can measure the outcome-if you offer a tubeworm a fish to eat, the tubeworm will either eat the fish or it won't.

Once you have your testable hypothesis, it's time to design and run an experiment or study. Offer the tubeworm a fish and see what happens. To verify your findings, use several tubeworms and offer each a fish to eat. (Note: Sometimes you don't need an experiment, but may choose to collect evidence instead. That'll be the focus of this activity. Subsequent activities will deal with experimentation.)

The fourth step is to note your results and draw a conclusion. Make sure that the conclusion you make is correct in light of your hypothesis. If the tubeworms didn't eat the fish in the experiment, a correct conclusion would be "Tubeworms don't eat fish." An incorrect conclusion would be "Tubeworms didn't like the fish offered" because it's impossible to measure a feeling such as "like."



The final step is to share what you learned with others so that they can benefit from your new-found knowledge.

This is your students' chance to exercise their powers of observation and to put the scientific method into action. During this activity your students will make new discoveries about nearby microhabitats. They'll record their observations, then make inferences about what they observed. Then they'll return to the study area to test their ideas, and finally share their ideas with others.

Hundred-Inch Hike

ACTIVITY

Materials
- stopwatch
- magnifying glass
- pencil and paper

Questions to Begin
- How to scientists make discoveries? (Have students offer their points of view, then explain the OPENS method.)

Procedure
1. Lay a 100-inch tape measure across each of several microhabitats on or near your school grounds. Possibilities include the sidewalk, lawn, forest trail, garden edge, meadow, etc.
2. Instruct students that they're going on a 100-inch adventure.
3. Have students pick (or assign them to) one of the microhabitats.
4. On their hike, students will make a list of 5 observations in one column, and a list of inferences (possible meanings) about those observations in another column (see the Observation Sheet). For instance, if a student notices a leaf that has a hole in it, she might write "leaf with hole in center" in the observation column and "a caterpillar chewed the hole" in the inferences column.
5. Gather students together and have each make a list of evidence they'll need to support each of their inferences. For the caterpillar example, finding a caterpillar eating the same kind of leaf and leaving a similar pattern would be strong evidence to support the inference.
6. Return to the micro-hikes areas and have students collect evidence to support or refute one of their inferences. If there's time, have them bolster their findings with additional evidence from nearby areas.
7. When they're done, have students present their observation, inference and evidence to support their discovery to the class.

Questions to Close
- What was your observation?
- What inferences did you make about what you observed?
- What evidence did you find to back up your conclusion?

Adapted from:
Cornell, Joseph. Sharing Nature with Children: Ananda Publications, 1979.
Gross, Phyllis, and Esther P. Railton. Teaching Science in an Outdoor Environment. Berkeley, CA: University of California Press, 1972.

Hundred-Inch Hike Observation Sheet

Student Name ____

Observations	*Inference*	*Necessary Evidence*	*Observed Evidence*
OBSERVATION 1			
OBSERVATION 2			
OBSERVATION 3			
OBSERVATION 4			
OBSERVATION 5			

Alien Species Study

OBJECTIVES

Students will discover that...

- animals, such as sow bugs, need air, water, food and shelter, and survive in the environments that meet their needs.

SUBJECTS
life science
GRADES
K-7
CONCEPTS
organisms and environments
DURATION
several 30- to 45-minute class sessions

BACKGROUND INFORMATION

One of the best parts about exploring a new frontier is learning about the species that live there. When faced with a new organism, the first questions a scientist tries to answer include, What is it? What does it eat? What environmental conditions does it need? How long does it live? During this activity your students get to see what it's like to discover how a species lives.

Have you ever taken a close look at a sow bug? A really close look? Examine one through a magnifying lens, and the first thing you'll notice is that its jointed body is split into sections, each with a pair of legs. Most people think of sow bugs as insects, but insects have three body parts and six legs. So what is a sow bug? It's a crustacean, a distant cousin of shrimps and crabs. Because they evolved from aquatic animals, sow bugs have a hard time retaining water. For breathing they have structures that work like gills, which have to stay moist to work. That's why you'll find sow bugs in damp places. The best places to look for them are under logs, stones or leaves, in cracks in the sidewalk, under planters, or other dark, damp places. Luckily for sow bugs, these are also places where they find food-primarily bits of decaying plants or animals.

ACTIVITY

Materials

- collecting tubs-margarine tubs or paper cups
- labels to place on the tubs
- plastic spoons
- spray bottle with tap water
- rulers
- hand lenses
- stopwatch
- graph paper

Questions to Begin

- Have you ever seen sow bugs in the forest or in a garden?
- Where exactly did you see them? Were they out in the open or were they under something?
- Where would you go to collect sow bugs?

Procedure

PART A

1. Take the class outside on a sow bug collecting trip. Give each child a small plastic container, such as an empty margarine tub, and a plastic spoon for collecting.
2. Instruct each child to collect five to ten sow bugs and a variety of leaves. On the label on each tub have students note where they found the bugs and the conditions under which the bugs lived (moist, dark, sunny, shady, hot, cool, wet, dry, hidden, in the open, etc.) Remind them to carefully replace lifted rocks and logs to their original position so as not to disturb other animals' homes.
3. Back in the class have each student examine their sow bugs. How many legs do they have? Where are their eyes? Where is the mouth? How many antennae does a sow bug have? How many body segments does a sow bug have? Do they all have the same number of body segments? Have students take a moment and sketch the sow bugs. Tell them to be sure to include all the body parts they just examined.

PART B

1. Set up two containers, each with identical sets of leaves; try to include the same numbers and sizes of leaves. It's okay to rip the leaves to even out the amount in each container.
2. Carefully count and measure each sow bug, then place them in one container. Gently mist with water from the spray bottle. The container with leaves but no sow bugs will serve as a control (something to compare with later). Loosely cover both containers, and place in a warm (not hot), dry place.
3. Monitor the sow bug population over the next couple of weeks. Each week measure sow bug size, and note which plant materials they eat in their container.
4. At the end of the study period, compare the sow bug container with the control container. Which has more leaves? Did the sow bugs grow? Did the number of sow bugs increase? If so, where did they come from? Be sure to check the control container (with no sow bugs) to see that the leaves are the same as when the experiment started.

PART C

Do the following experiment:

1. Place 5 sow bugs in a dish and set in an open, lighted place.
2. Cover part of the dish with paper and let set 15 to 30 minutes.
3. When you return, where are the bugs — in the lighted part or the covered part? Why?

Questions to Close

- Is a sow bug a type of insect? Why or why not?
- If not, what type of animal is it?
- Do sow bugs remind you of another type of animal?
- What do sow bugs eat?
- What environmental conditions does a sow bug need (light or dark, moist or dry)?
- Where in a forest or garden would you expect to find sow bugs?

Adapted from:
Kneidel, Sally Stenhouse. Creepy Crawlies and the Scientific Method: Over 100 hands-on science experiments for children. Golden, CO: Fulcrum Publishing, 1993.

Seeing in the Sea

OBJECTIVES

Students will discover that...

- in the dark, some colors are easier to see than others.
- mid-water and deep-sea animals behave in ways that are related to the lack of light in their environments.

SUBJECTS
physical science, life science
GRADES
2 - 6
CONCEPTS
color and light
DURATION
one 30- to 45-minute class session

BACKGROUND INFORMATION

An expedition to the deep sea means an expedition into darkness. Things are going to look very different down there. Understanding what you'll be seeing will require a sense of how differently things look in the dark.

When light shines into the ocean, particles in the water and water molecules themselves absorb or scatter the light. Blue light penetrates deeper into the sea than red light. At mid-water depths, where light levels are very low, organisms are often red or orange — two colors that are impossible to see because there's no red or orange light to illuminate them.

At about 300 to 1,000 feet (100 to 300 meters) depth, depending on water clarity, there's no light at all-it's pitch black. Deep-sea organisms use the lack of light to their advantage. Some carry their own light as sacs of bioluminescent (light-producing) bacteria. Others have special cells called photophores that produce light from chemical reactions. By carrying a personal light source, a deep-sea organism can hide in the open until it flashes to attract a mate, issue a warning or confuse a predator.

ACTIVITY

Materials

- construction paper: at least 6 different colors, one of each colored sheet for each student
- cardboard fish stencils

Questions to Begin

- What happens to colors in the dark?

Seeing in the Sea

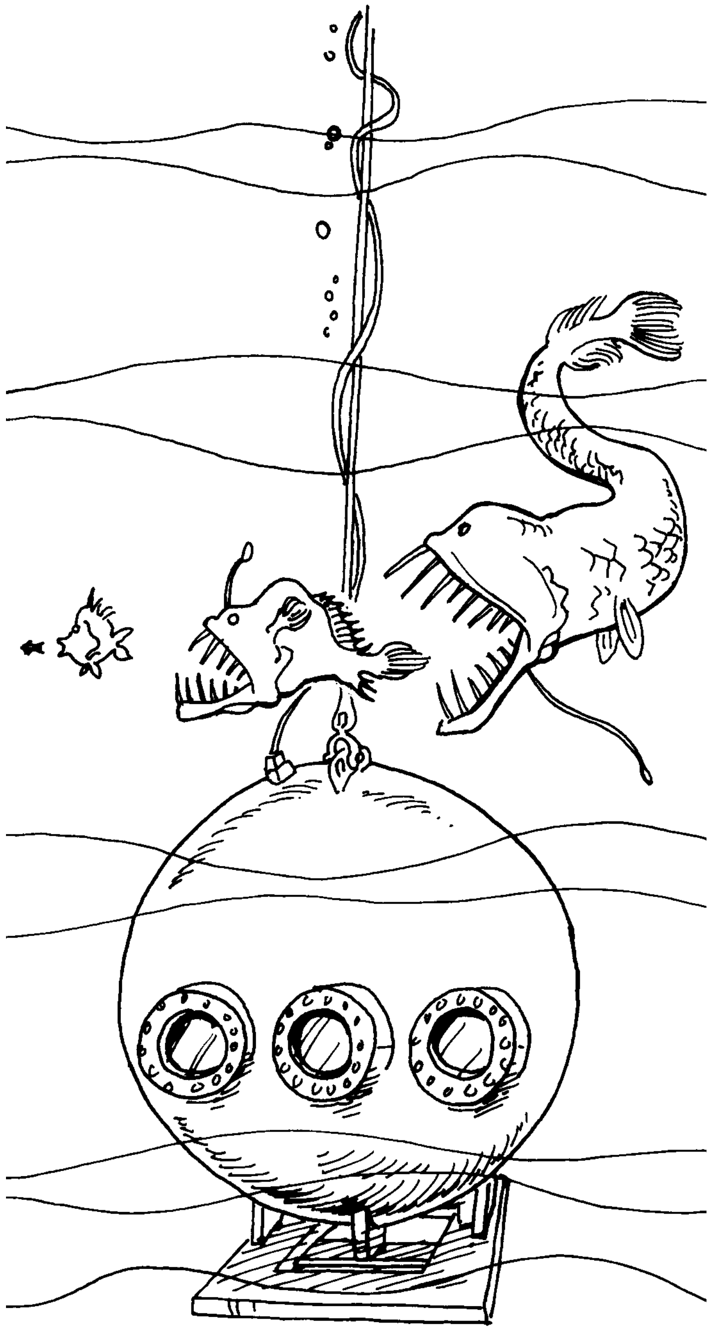
- In the dark do you think you can see certain colors better than others?

Procedure

1. Ahead of time, cut several fish-shape stencils out of cardboard, one for each student.
2. Hand out different colored sheets of construction paper. Give each student a cardboard fish stencil.
3. Have students trace the outline of the cardboard fish stencil on different colors of construction paper (red, light blue, green, yellow, dark blue and black) and then cut out their paper fish. Make sure each student has a set of six fish, one of each color.
4. Make sure students are seated, then turn out the lights.
5. Have students place their fish in the following order: black, red, dark blue, green, yellow, light blue.
6. Turn on the lights so they can check their work.

Questions to Close

- Which colors could you see best in the dark? Which ones were hard to tell apart?
- If you were a deep-sea organism, what color would you like to be? Why?
- If you were a hard-to-see deep-sea organism, how would you find another of your species?
- If you were a deep-sea explorer, how would you look for hard-to-see organisms? What special equipment would you want to have along?
- In the deep sea, do you think shining lights might attract or scare away organisms?



Sounding Seafloors

OBJECTIVES

Students will discover that...

- features of the seafloor include the continental shelf, continental slope, continental rise, seamounts, canyons, mid-ocean ridges and islands.
- the scale chosen for measurements makes a big difference in how useful your results are.
- mathematics is essential to asking and answering questions about the natural world.

SUBJECTS
geography, geology, mathematics
GRADES
6 - 12
CONCEPTS
mapping the seafloor
DURATION
three to four 45-minute class sessions

BACKGROUND INFORMATION

In 1872, a ship named the *Challenger* left England on a voyage to study the world's seas. One of the expedition's goals was to measure the depths of the world's oceans. Using a technique called sounding, scientists lowered a rope or cable into the water until a weight tied to the end of the rope hit bottom. The length of the rope indicated the ocean's depth at that place. Results weren't very precise, however, because the cable often bowed or broke, and the distance between soundings was too great to detect the finer details. Today, cutting-edge technologies have improved our sense of seafloor topography.

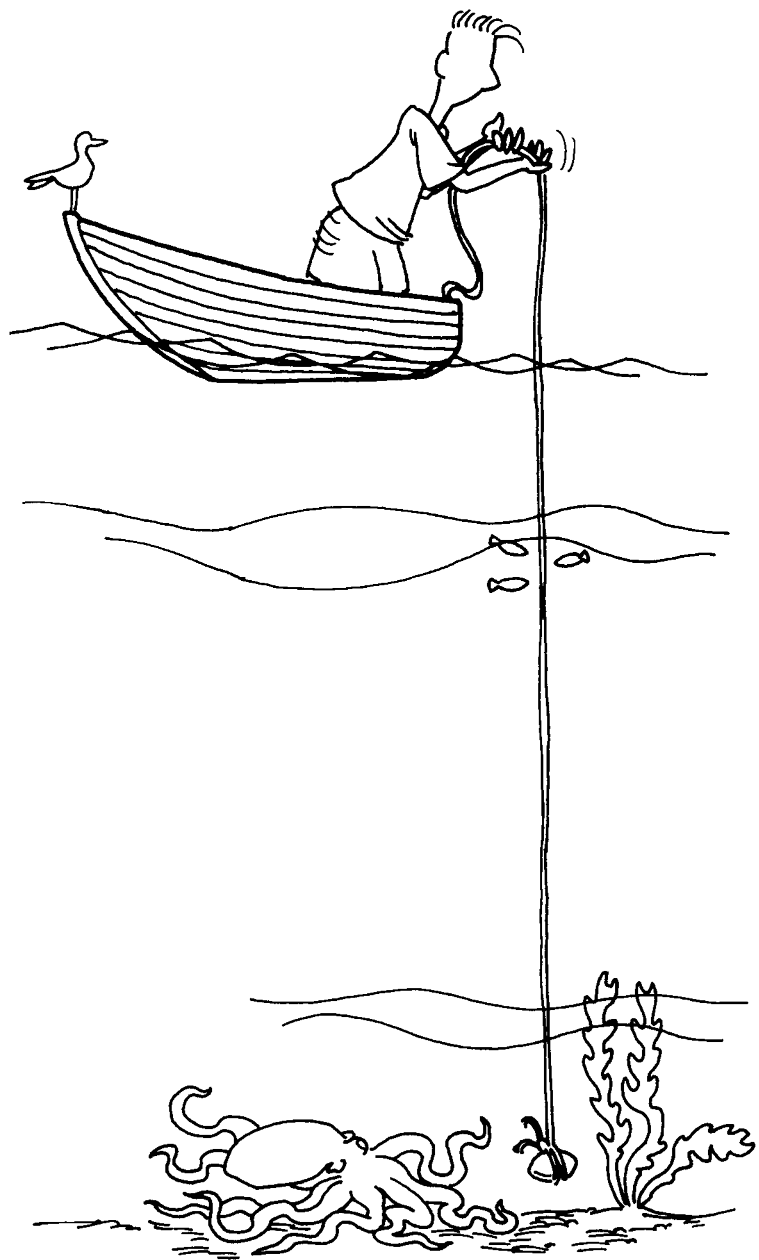
Imagine a voyage along the bottom of the Atlantic Ocean, starting at Martha's Vineyard and heading toward Gibraltar, and you'll encounter many typical seafloor features. At first the seafloor slants gently as the water grows deeper. This is the continental shelf, the part of the North American continent that's underwater. At about 70 miles (113 km) from shore, the bottom's slope steepens. This is the continental slope, which continues until you reach what's called the continental rise.

When the bottom flattens out, you've reached the ocean's basin. About 860 miles (1390 km) from shore lies the abyssal plain, the flattest part on Earth, where sand and silt have accumulated for ages. Eventually the abyssal plain ends 280 miles (460 km) later, as you reach the first of many seamounts – underwater volcanoes that are working their way to the ocean's surface. About halfway through the journey, you reach the largest feature of all, the mid-Atlantic ridge. This is an undersea mountain range where seafloor is born, and plates of the Earth's crust are forced outward. As you travel on, you pass over canyons and more seamounts, one of which reaches the surface, forming islands called the Azores. Continuing on, the ocean basin gently rises again to meet the continent of Europe.

Sounding Seafloors

Absent from the Atlantic is a feature called an ocean trench. An ocean trench forms where two plates of the Earth's crust meet and one dives below the other. Trenches are the deepest parts of the ocean. The deepest trench is the Marianas Trench, off the Marianas Islands east of the Philippines.

During this activity, your students will make, then explore, miniature seafloors. When they visit Extreme Deep: Mission to the Abyss, they'll learn additional ways that scientists explore the ocean's depths.



ACTIVITY

Materials
(for each pair of students)

- one large shoe box with lid
- clay
- a bamboo skewer
- 2 fine-tipped marker pens, one red and one black
- nails for poking holes in the shoe box
- masking tape
- one sheet of graph paper
- pencils

Questions to Begin

- If you were in a boat on a shallow pond and wanted to know how deep the water was, how would you find out?
- Do you have any ideas how you'd find out the depth of the ocean in a certain place?

Procedure

1. Have students pair up.
2. Each team builds a seafloor using clay to form the seafloor features in the bottom of their shoe box. Make sure they make their seafloors realistic, with a continental shelf and slope, offshore trenches, mid-ocean ridges, islands and other features in appropriate places.
3. Students mark their boxes so they can identify them later.
4. When the seafloor is completed, have each team tape a sheet of graph paper to the inside of the box top. Working from the inside of the box top, poke a small hole through the paper and box top at each intersection on the graph paper.
5. Remove the graph paper. Replace the box top onto the box to represent sea level and tape shut. Tape the graph paper to the top of your mini-ocean being sure to realign the punched paper with the holes on the lid.
6. Place in a warm dry place so the clay can harden.
7. Later in the week, have teams swap oceans. Make sure students don't look into the boxes.
8. Hand out one bamboo skewer to each team. Instruct students to mark the skewer every 1/4 inch with a black fine-tipped marker pen. Every fourth mark (at each inch) should be red.
9. Teams make soundings by gently sliding the bamboo skewer through each hole in the box top, row by row. For each sounding, have them note the level that the box top reaches on the skewer, then remove the skewer and record the depth on the graph paper.
10. Students chart their results to identify trenches, sea mounts, ridges, etc.
11. Once their charts are finished, have students open their boxes and compare the box seafloor with their graph-paper results.

Questions to Close

- Were you able to locate all the features in your "ocean"?
- If not, which features didn't you locate by sounding?
- What can you conclude about the accuracy of your method?
- How would you improve upon your method?
- What would happen if your skewers were marked every 1/8 inch instead of every 1/4 inch?

Adapted from:
FOR SEA-Marine Science Society of the Pacific Northwest. J.A. Kolb, 1993.
Stevens, Betsy, and Amy Pallant. "Build the Ocean Floor" In Dive to the Deep Ocean; Voyages of exploration and discovery; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
Stevens, Betsy, and Amy Pallant. "Map the Ocean Floor" In Dive to the Deep Ocean; Voyages of exploration and discovery; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
Sources
Gross, M. Grant. Oceanography: A view of the Earth. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1972.
Smith, Walter H. OF., David T. Sandwell. 1997. "Global seafloor topography from satellite altimetry and ship depth soundings." Science 277: 1956-1962.

Oh! The Pressure

OBJECTIVES

Students will discover that...

- water pressure increases with depth.

SUBJECTS
physical science, oceanography, mathematics
GRADES
4 - 7
CONCEPTS
deep sea environment
DURATION
one 45-minute class session

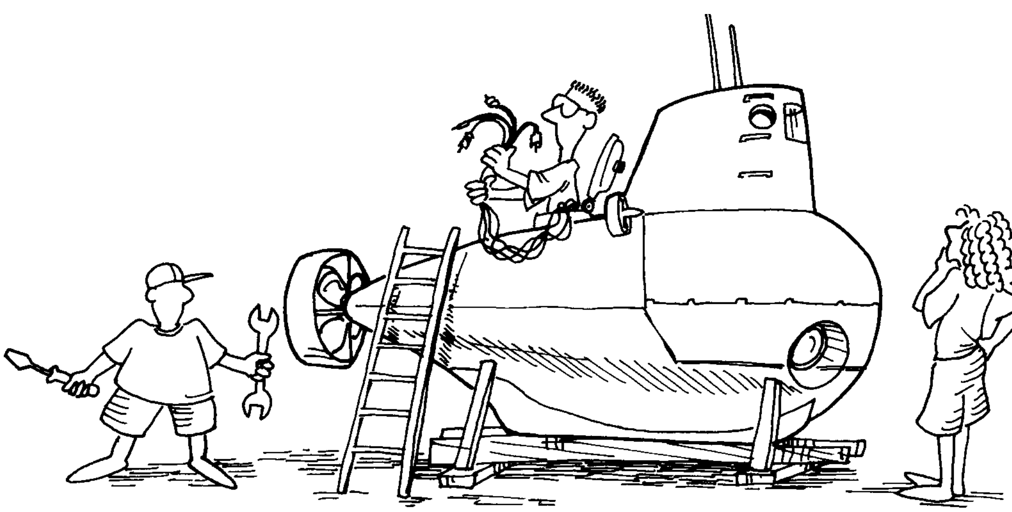
BACKGROUND INFORMATION

The farther down into the sea you go, the more pressure there is. The equipment that visits the deep sea must be strong enough to withstand crushing pressure.

At sea level, the atmosphere constantly presses against you. The force with which it does so is about 14 pounds per square inch, also known as one atmosphere of pressure. When you jump into a swimming pool or the ocean, water presses against you. Because water is denser than air, it pushes against you with a greater force than air does. The strength of that force depends on how deep you go and therefore how much water is pressing upon you.

For every 33 feet (10 meters) of water depth, the pressure increases by 1 atmosphere. So at the water's surface the water pressure is the same as the air pressure: 1 atmosphere. Thirty-three feet down, the pressure doubles to two atmospheres. At 330 feet it's 11 atmospheres. Imagine the pressure two miles below the sea!

Because water isn't compressible (crushable), pressure isn't a problem for water-filled objects. Because air is compressible, pressure crushes air-filled vehicles-unless they're reinforced.



This simple activity will demonstrate to your students that water pressure increases with depth. Afterward, they will design a craft that can take them to the deep sea while withstanding crushing pressure.

ACTIVITY 1

Materials

- 2 milk cartons (1/2 gallon and 1 pint) for each team
- 1 rectangular baking pan for each team
- nail or other tool for punching holes in the container for each team
- ruler for each team
- duct tape
- water

Questions to Begin

- Has anyone ever dove to the bottom of a swimming pool and felt water pressure on their ears?
- What do you suppose causes that pressure?

Procedure

1. Have each team cut the top off each of the two milk cartons. Use a pencil or nail to punch three holes in the side of each carton. The holes should line up vertically and be equally spaced with the top hole at least 1.5 inches from the top of the carton. The lowest hole in both cartons should be the same distance up from the bottom.
2. Cover the holes with duct tape.
3. Place the small carton at one end of a rectangular pan with the taped holes facing the opposite end.
4. Lay a ruler along one edge of the pan with the one-inch edge lined up with the holed edge of the milk carton.
5. Fill the carton with water.
6. Remove the tape and observe the water streaming from each hole. Measure the horizontal distance the water squirts from each hole.
7. Record the results on a chart of distances. Label the columns "one-pint carton" and "half-gallon carton." Label the rows "top hole length," "middle hole length" and "bottom hole length."
8. Dump the water from the pan and milk carton and repeat the activity with the half-gallon carton. Measure and record the distance the water spurts out from each hole.

Questions to Close

- Which stream of water shot out the farthest in each container — the top, middle or bottom hole? Why?
- Which stream of water shot out the farthest-the stream from the bottom hole in the pint carton or the stream from the bottom hole in the half-gallon carton?

- If each milk carton were an ocean, which would have the most water pressure at its bottom?

ACTIVITY 2

Materials
- drawing paper
- crayons, colored pencils or other art supplies

Questions to Begin
- Do you think an increase in pressure with depth poses a problem for researchers who build ROVs and other deep-sea equipment?
- If you were designing an ROV or submarine, how would you make it strong enough to withstand pressures of the deep sea?

Procedure
1. Tell your students it's now time for them to invent a deep-sea explorer that's strong enough to withstand the pressures of the deep sea. Instruct them to pick a task such as retrieving a sunken ship or collecting rock samples, and a depth at which their invention will be working so that they can design the craft to meet their needs.
2. Have each student calculate the pressure in pounds per square inch that their craft will need to withstand at a designated depth. The formula to use is:
3. [depth in feet ÷ 33 feet] + 1 atmosphere = total pressure in atmospheres.
4. To convert the answer to pounds per square inch, multiply it by 14
5. (1 atmosphere = 14 pounds per square inch).
6. When everyone is finished, have students share their artwork and ideas with the class, pointing out special features their invention has and the use of those features.

Questions to Close
- How much pressure must the craft you designed withstand at the depth you've indicated?
- What two things would you include as part of your deep-sea craft to make sure it could withstand the pressure of the deep sea?

Adapted from:
Lowery, Lawrence F. The Everyday Science Sourcebook. Boston: Allyn and Bacon, Inc., 1978.
Ranger Rick's Nature Scope. Diving Into Oceans. Saltwater Wonders (Ranger Rick) handout.
Stevens, Betsy, and Amy Pallant. "Testing Water Pressure." In Dive to the Deep Ocean; Voyages of exploration and discovery; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
Stevens, Betsy, and Amy Pallant. "Create a Model Submersible." In Dive to the Deep Ocean; Voyages of exploration and discovery; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
Sources
Gross, M. Grant. Oceanography: A view of the Earth. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1972.

Build a Deep-Sea Vent

OBJECTIVES

Students will discover that...

- hydrothermal vents are complex communities made up of producers, consumers and decomposers.
- hydrothermal vent communities are as complex and interdependent as communities on land.

SUBJECTS
life science, art
GRADES
K - 6
CONCEPTS
ecosystems
DURATION
several 30- to 45-minute class sessions

BACKGROUND INFORMATION

The discovery in 1977 of lush, complex communities at hydrothermal vent sites in the deep sea surprised scientists. Until that time, they believed the deep sea was sparsely inhabited. They believed this was because of a lack of food. When they discovered giant tubeworms, fishes, crabs, limpets, and other organisms thriving in communities based on bacteria rather than plants, scientists were forced to rethink their ideas that all life is based on energy from the sun. They had found evidence that energy from the Earth itself could sustain life.

On land and in shallow waters, plants convert carbon dioxide and water into sugar using energy from the sun. This process is called photosynthesis. Animals eat the plants, or they eat other animals. When plants and animals die, decomposers reduce their remains into nutrients that plants can use. Because plants are the original food makers, they're called producers. Animals that eat plants or other animals are consumers. The clean-up crew — bacteria and fungi — are decomposers.

In the ocean, most life follows a similar regime. Most deep-sea organisms rely on organic matter drifting down from above. You can trace the origins of that organic matter to photosynthesis. But in certain parts of the deep sea, where volcanic activity creates hydrothermal vents, bacteria metabolize volcanic chemicals and use the resulting energy to produce food. At deep-sea hydrothermal vents, there are no plants. Bacteria take their place as producers.

With this activity, your students will have a chance to explore the amazing world of hydrothermal-vent communities by building a model of one in the classroom. You can use the materials we've suggested here or come up with some creative ideas of your own.

Build a Deep-Sea Vent

ACTIVITY

Materials

- construction paper
- cardboard
- black tissue paper
- white or yellow string
- scissors
- tape
- glue
- straight pins
- glass jars (about 4 inches in diameter)
- wire coat hangers
- fishing line
- fishing weights, glass marbles, small round rocks or other heavy objects
- decorative items: buttons, etc.
- spray paint (or other paint): gray, red and white; other colors optional
- colored markers
- several foam sheets, 1/4-inch and 1/2-inch thick
- reference books on deep-sea hydrothermal vents

Questions to Begin

- What is a hydrothermal or deep-sea vent?
- What's special about the communities living at hydrothermal vents? How are they different from communities living in other places on the deep sea?

Procedure

1. Have students bring in pictures (from magazines), study pictures you've brought in, or view a video of deep-sea hydrothermal vents.
2. Using pictures for reference, have students make deep-sea organisms — pink fish, white crabs, rosy tubeworms, etc. — out of construction paper. As they cut out organisms, have them identify

each as a producer, consumer or decomposer. (If they need to, students can refer to reference books for additional information. Ask your librarian for recommendations.) Decorate the organisms with markers, buttons (for eyes), etc.

3. Make mineral chimney vents out of 1/2-inch thick foam. Cut a square piece of foam, approximately 3 feet long by 3 feet wide. Roll the foam to connect the long edges and tape together with duct tape. Take outside and paint gray (be sure to lay down newspaper to protect your work area). When the paint dries, bring back inside and stuff black tissue paper into the holes to represent hot water spewing from a "black smoker."
4. Make tubeworms similar to the way you make the mineral chimneys. Start with the tubes. Cut rectangular strips of 1/4-inch-thick foam 3 to 4 feet long and about 1 foot wide. Roll the foam to connect the long edges and secure with tape. Paint white. To make the red tips, cut out two pieces of 1/4-inch-thick foam 6 inches long and 3 to 4 inches wide (they should be about as wide as the inside diameter of the worm's tube). Paint one side red and the other white. Sandwich the white sides together and glue. Insert into the white tube and secure in place with straight pins (careful with the pins!) or tape.
5. Make a base for the worms by filling a jar (about 4 inches wide) with fishing weights, glass marbles, or other heavy items. Straighten out a wire coat hanger and insert one end into the jar so that the other end points upward. Slip your tubeworm over the hanger and jar. The hanger should keep your worm upright.
6. For bacteria mats, you can use white or pale yellow string. Wad up and drape around your vent site.
7. Assemble the hydrothermal vent site in a corner of the classroom. You can tape crabs to the sides of the mineral chimneys, hang paper fish from the ceiling using fishing line, and attach tubeworms. Use the pictures you've brought in to help you decide where things should go.

Questions to Close

- In a hydrothermal-vent community, which organisms are the producers?
- Which are the consumers?
- Which are the decomposers?
- Does the hydrothermal-vent community remind you of a community you've seen on land? If so, which one(s) and why?

Adapted from
Acerno, Karen. Extension Activity 3, "What Tools Do Scientists Use?" In Off To Sea; An inside look at a research cruise; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.

Crazy Currents

OBJECTIVES

Students will discover that...

- wind creates ocean surface currents.
- sea water has characteristic properties, such as temperature, salinity and density.
- temperature and salinity affect ocean currents.
- cold water is denser than hot water, so it tends to sink.
- salt water is denser than fresh water, so it tends to sink.

SUBJECTS
oceanography
GRADES
5 - 8
CONCEPTS
ocean circulation
DURATION
one 45-minute class session

BACKGROUND INFORMATION

In May 1990 during a storm, a shipment of Nike tennis shoes was accidentally dumped into the ocean about 500 miles southeast of Alaska. An oceanographer named Dr. Ebbesmeyer began tracking the wayward tennis shoes as they landed on shore. Before long, shoes were washing up in Washington and Oregon, and later, in Hawaii.

Ebbesmeyer was tracking the tennis shoes to learn about currents. The most commonly understood currents are those caused by wind. Wind blowing across the ocean pulls surface water along. This water in turn pulls along deeper water. The greater the wind force, the deeper its influence. These “rivers” of sea water travel horizontally, usually along the ocean’s surface. The Gulf Stream in the Atlantic and the Humboldt Current in the Pacific are two examples.

Another type of current is caused by differences in water temperature and salinity. Because cold water is denser that warm water, colder water sinks below warmer water. The same is true for differences in salinity: saltier water sinks below less salty water. When bodies of water with differing salinities or temperatures meet, the water masses sort themselves out, creating currents. These currents are called thermohaline currents, and they move vertically as well as horizontally, in deep waters as well as surface waters.

These activities will help your students investigate the forces that create ocean currents.

ACTIVITY 1

Materials

- none

Questions to Begin

- none

Procedure

1. Read the first paragraph of the background information about Ebbesmeyer and the shoes to your students, then ask them, "Why was Ebbesmeyer interested in tracking tennis shoes?"

ACTIVITY 2

Materials

For each team:

- pan of water (at least 2 feet long, 1 foot wide and 6 inches deep)
- small Styrofoam(TM) chips, small paper strips or crumbled cork pieces
- straws

Questions to Begin

- What happens when the wind blows over the surface of the ocean?

Procedure

1. Divide the class into teams. Have each team float small Styrofoam(TM) chips, small paper strips or crumbled cork in a pan of water.
2. Have a team member blow a straw over the water's surface and watch water movements.
3. Have two people position themselves at either end of the pan and gently blow over the waters' surface toward each other.

Questions to Close

- What would happen if the winds blew over the ocean in the same direction for long periods of time?
- What happened when the two currents met?

ACTIVITY 3

Materials

- 4 one-pint containers
- 2 clear plastic cups
- table salt
- hot tap water and cold tap water
- red and blue food coloring
- medicine dropper

Questions to Begin

- What happens when two bodies of sea water with different temperatures meet in the ocean?

Procedure

AHEAD OF TIME

1. Make a stock solution of cold salt water. Mix one cup of tap water and 1 1/2 teaspoons salt into a container. Label it "Cold Solution" and refrigerate two hours.

SET UP

1. Make a stock solution of hot salt water. Mix one cup of hot tap water and 1 1/2 teaspoons salt in a second container and label it "Warm Solution." Keep it warm.
2. Pour a small amount of the cold solution into a third container. Stir in 4 to 5 drops of blue food coloring.
3. Pour a small amount of the warm solution into a fourth container. Stir in 4 to 5 drops of red food coloring.

EXPERIMENT & STUDENT OBSERVATIONS

1. Have students note and share observations as you (or they)...
2. Pour 2 inches of the cold solution into the clear plastic cup. Using the dropper, add about 20 drops of the red (warm) water.
3. Pour 2 inches of the warm stock solution into another clear plastic cup. Add about 20 drops of the blue (cold) water.

Questions to Close

- What happened as the blue (cold) salt water dripped into the warm salt water? Why?
- What happened as the red (warm) salt water dripped into the cold salt water? Why?

ACTIVITY 4

Materials

- cold tap water
- table salt
- 4 one-pint glass containers
- 2 clear plastic cups
- red and blue food coloring
- eye dropper

Questions to Begin

- Do you think differences in salinity can cause water currents to form?

Procedure

SET UP

1. Make a stock saltwater solution in a pint container by mixing 1 1/2 teaspoons of salt in 1 cup of warm tap water. Label it "Salt Water."
2. Into a second pint container, mix 3 teaspoons of salt in 1 cup of warm tap water and label it "Super Salt Water."
3. Transfer a small amount of "Salt Water" to a third container. Add 4 or 5 drops of red food coloring.
4. Transfer a small amount of "Super Salt Water" to a fourth container. Add 4 or 5 drops of blue food coloring.

EXPERIMENT & STUDENT OBSERVATIONS

1. Have students note and share observations as you (or they)...
2. Pour 2 inches of "Super Salt Water" (not colored) into a clear plastic cup. Using the dropper, add about 20 drops of the red water, which is less salty.
3. In another plastic cup, pour in 2 inches of "Salt Water" (not colored). Using the dropper, add about 20 drops of blue super salty water.

Questions to Close

- What happened as the blue, super-salty water dripped into the less-salty water?
- What happened as the red salt water dripped into the super-salty water?

Crazy Currents

ACTIVITY 5

Materials

- 1-cup measuring cup
- 1 cup warm tap water
- 1 1/2 teaspoons salt
- 9x13" glass baking dish
- plastic ice cube tray
- refrigerator and freezer

Procedure

1. In a measuring cup, dissolve 1 1/2 teaspoons salt in 1 cup of warm tap water.
2. Add 4 or 5 drops of red food coloring. Fill 4 compartments of an ice cube tray half-full with the red salt water and freeze.
3. Fill a glass baking dish with lukewarm water. Line up the 4 ice cubes at one end of the dish. (Move them back into place if they float away.)
4. Look into the dish from the side. Have students note and compare their observations.

Questions to Close

- What happened as the ice cubes melted? Why?

Adapted from:
Ranger Rick's Nature Scope. Diving Into Oceans. Saltwater Wonders (Ranger Rick) handout.
Sources:

"Deep-sea currents driven by wind." Science News, August 31, 1985. p. 141.
"Following the track of 80,000 wet Nikes." Science News, Sept. 19, 1992. p. 189.

Seafloor Spreading Centers

OBJECTIVES

Students will discover that...

- the Earth's crust is made of several sections, called plates. The plates move slowly over time, changing the positions of the continents.
- the Earth's crust is always changing. Sometimes these changes result in earthquakes, volcanic eruptions and mountain building.
- new crust forms at seafloor spreading centers, where magma erupts and cools.

S U B J E C T S
geology, geography
G R A D E S
5 - 7
C O N C E P T S
plate tectonics
D U R A T I O N
one to two 45-minute class sessions

BACKGROUND INFORMATION

Some of the most exciting discoveries have been made by accident. One such recent discovery happened when scientists went down into the deep sea to study areas of the ocean floor called seafloor spreading centers. What did they find by accident?

According to the theory of plate tectonics, the earth's crust is composed of approximately 20 large sections called plates that piece together like a jigsaw puzzle. Over time, these plates move, shifting the position of the continents relative to each other. The shifting of plates is one cause of earthquakes.

Seafloor spreading centers mark the birthplace of Earth's plates. Volcanic eruptions spew molten rock into the deep sea, where it quickly cools and becomes new seafloor. Over time, eruptions slowly push the plates outward. The edge of the plate being formed is called the trailing edge. The opposite edge is the leading edge. Because it's farthest from the seafloor spreading center, it's the oldest edge. Where the leading edge of one plate meets the leading edge of another, the two collide. Often, one plunges under the other and a deep trench forms. It is in these trenches that the seafloor is forced deep into the Earth.

With this activity your students will piece together pieces of the earth's crust to see plate tectonics in action.

Seafloor Spreading Centers

ACTIVITY

Materials
- world map
- scissors
- cardboard
- paste

Questions to Begin
- Have you ever felt an earthquake?
- What do you suppose caused the earthquake?

Procedure
1. Split the class into teams of 3 or 4 students.
2. Photocopy a world map, one for each team of students, and pass out to the teams.
3. Have teams cut out the continents and figure out a way that they might fit together.
4. Paste the continent puzzle onto piece of cardboard.
5. Teams present their model to the class.

Questions to Close
- Have the earth's continents always been in the same position?
- What evidence do you have that suggests the continents haven't always been in the same position?
- Did everyone come up with the same re-arrangement of continents?

Adapted from:
Science: Model Curriculum Guide, Kindergarten Through Grade Eight. Sacramento: California State Department of Education, 1987.

Explorer Interview

OBJECTIVES

Students will discover that...

- creativity, imagination and a good knowledge base are all required in the work of explorers and scientists.

SUBJECTS
language arts, history
GRADES
6 - 12
CONCEPTS
exploring and explorers
DURATION
one 45-minute class session

BACKGROUND INFORMATION

Just about anybody can be an explorer. A geologist explores rocks for clues about earth's past. An astrophysicist explores outer space for clues of new planets. An archaeologist explores ancient cities to learn about past cultures. A marine biologist explores the ocean for new plants or animals. Artists and writers are explorers, too. They explore their imaginations for new ways of looking at the world. Part of the fun of exploring is sharing what you've found and igniting curiosity about your discoveries in other people.

During this activity your students get to meet and interview some real live explorers.

ACTIVITY

Materials

- none

Questions to Begin

- If you were to meet a real live explorer, what kinds of things would you ask that person about his or her discoveries?

Procedure

1. Students can work alone or in pairs. Each student or team chooses a person from the community who is an explorer. The person can be a scientist, university researcher, artist, naturalist, etc. He or she may be a friend of the family or a public personality.
2. Students or teams interview that person about their "quest" and how he or she goes about finding what they're looking for. Be sure to cover the topic of technology — what technological advances have been made over the years and how that technology helps them. If possible, the interviews can take place over the Internet using e-mail.
3. Students or teams write up their findings and present them to the class.

4. If possible have each team (or one team to represent the class) publish an Explorers newsletter. This can either be in print or on the World Wide Web as an Explorers Website.

Questions to Close

- What was the explorer's goal?
- Did he or she meet that goal?
- What three things contributed to that person's success/failure?
- Would you have done anything differently?
- What's the main thing your explorer learned on his or her expedition?

Adapted from:
Stevens, Betsy Franz. Extension Activity 3, "What is the Future of Hydrothermal Vent Ecosystems? In Down to a Sunless Sea; The strange world of hydrothermal vents; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.

Deep-Sea Scavenger Hunt

SUBJECTS
life science, oceanography
GRADES
6 - 8
CONCEPTS
deep-sea environment
DURATION
one 20- to 30-minute class session to present the scavenger hunt; one 45-minute class session to review each team's findings

OBJECTIVES

Students will discover that...

- they have a lot in common with the deep sea and deep-sea explorers.
- one way to make sense of something is to think about how it's like something more familiar.

BACKGROUND INFORMATION

By now your students should be pretty good explorers. And they should know quite a bit about the deep sea. Here's a chance for them to combine their new fields of expertise and demonstrate how well they know their stuff.

ACTIVITY

Materials

- shoe boxes or other containers for collecting items (one for each team)
- one copy of the Scavenger List for each student
- prize or prizes

Questions to Begin

- none

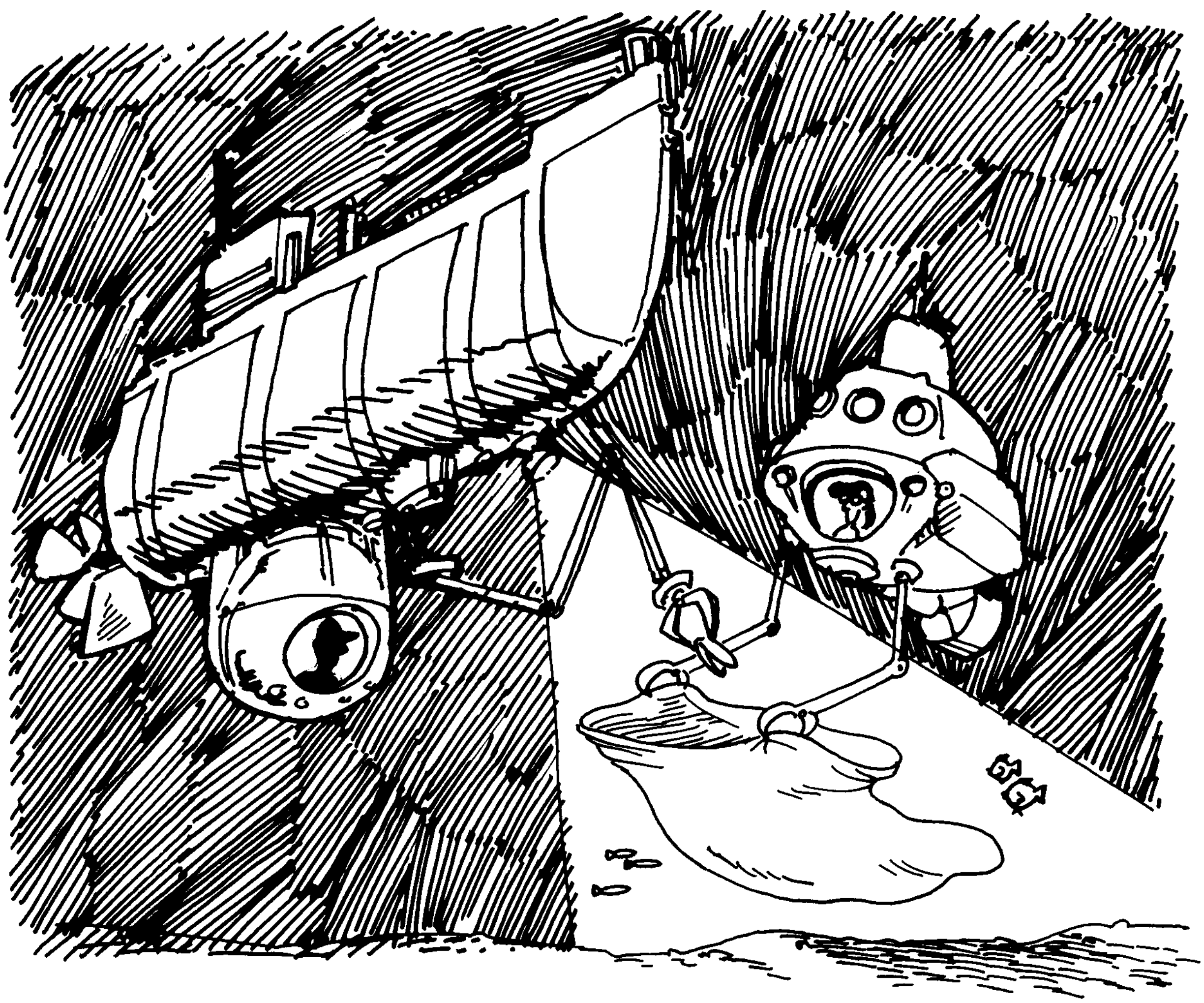
Procedure

1. Copy the Scavenger List and give one to each student.
2. Split students into teams of two or three. Each team is to find an everyday object for as many clues on the Scavenger List as possible. When students find an object that matches the clue, they are to store it in their team's shoe box.
3. When the everyday objects are living things or belong to someone else, encourage your students to bring photos or make drawings rather than collect the real thing.
4. Give the class two to three days to collect objects and to complete their lists.
5. At the end of the given time period, have each team present their results. Instruct them to identify each object and the category it represents, and to justify their answers.

6. A scorekeeper keeps a list of each team's approved items on the board.
7. If an item collected is questionable, the class votes whether to accept or reject the item.
8. The team (or teams) with the most items correctly "scavenged" wins a prize.

Questions to Close

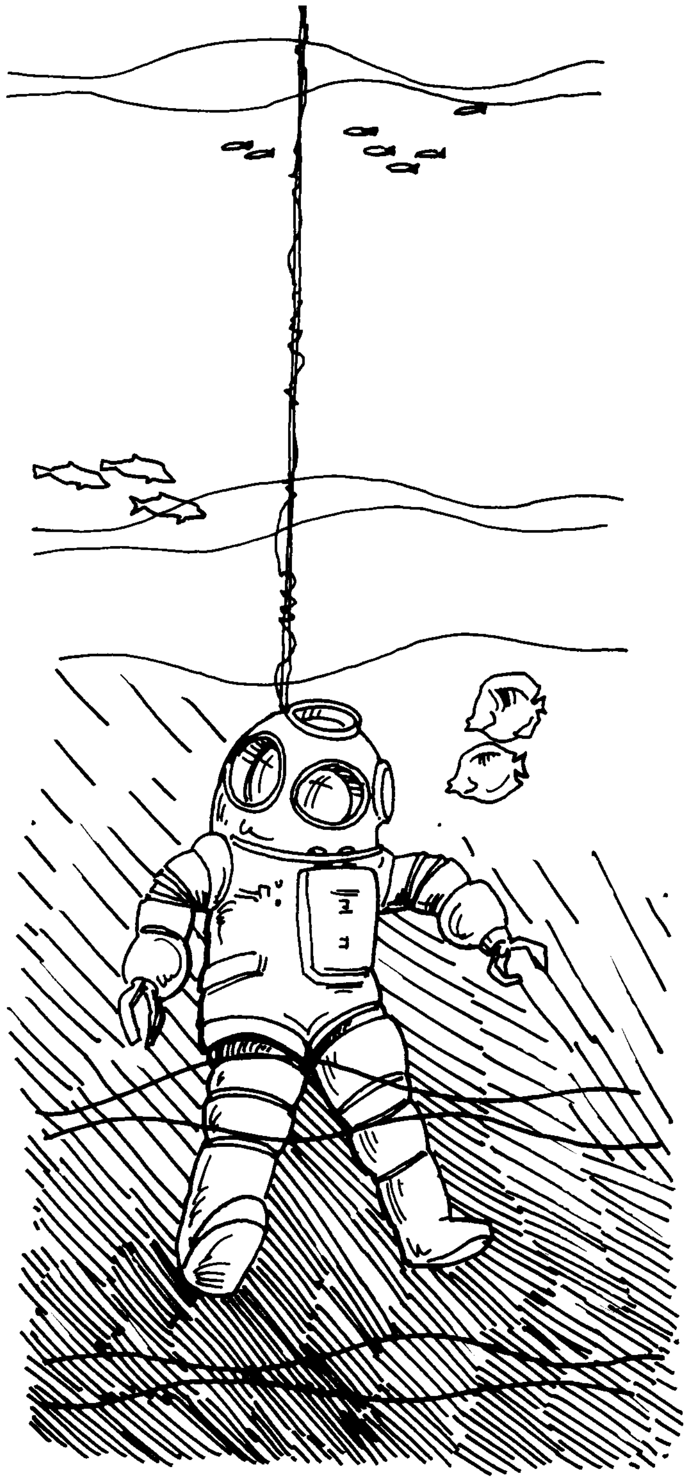
- none



Adapted from:
Gross, Phyllis, and Esther P. Railton. Teaching Science in an Outdoor Environment. Berkeley, CA: University of California Press, 1972.
Shaffer, Carolyn, and Erica Fielder. City Safaris. San Francisco: Sierra Club Books, 1987.

Scavenger List

OBJECTIVE



Find an everyday object or organism on land that....

1. bioluminesces (produces its own light)
2. might smell like a hydrothermal vent (think sulfur!)
3. is rich in the same minerals that vent water has (think iron and magnesium)
4. has the same food-chain role as chemosynthetic bacteria
5. is related to deep-sea shrimp
6. would change size or shape with an increase of pressure
7. would not change size or shape with an increase of pressure
8. is the one thing you'd definitely want if you were to take a dive in Alvin
9. could help you track ocean currents
10. uses chemical energy to produce something
12. has the same kind of relationship with another organism as tubeworms have with chemosynthetic bacteria
13. a deep-sea oceanographer would have in his or her shipboard lab
14. is always in the dark
15. uses camouflage for protection
16. no explorer would want to leave home without
17. has the same consistency as a deep-sea jelly
18. resembles the plates of Earth's crust
19. has the same food-chain role as a vent crab
20. has the same texture that you imagine deep-sea mud has
21. has something in common with Remus

Extreme Deep Wordplay

OBJECTIVES

Students will...

- identify words and concepts related to the deep sea and to exploration.

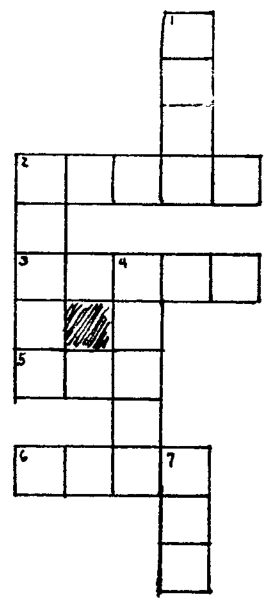
SUBJECTS
language arts
GRADES
2 - 12
CONCEPTS
ocean exploration
DURATION
10 to 30 minutes

BACKGROUND INFORMATION

This activity gives your students a chance to practice vocabulary words they've learned about the deep sea and about exploring new frontiers.

CROSSWORD PUZZLE

GRADES 2 - 3
What lives at vents?



ACROSS

2. These vent animals have two shells.
3. Name of the sub people use to visit vents.
5. The bottom of the sea is dark because the ___ doesn't shine there.
6. Some pink ____ live only at vents.

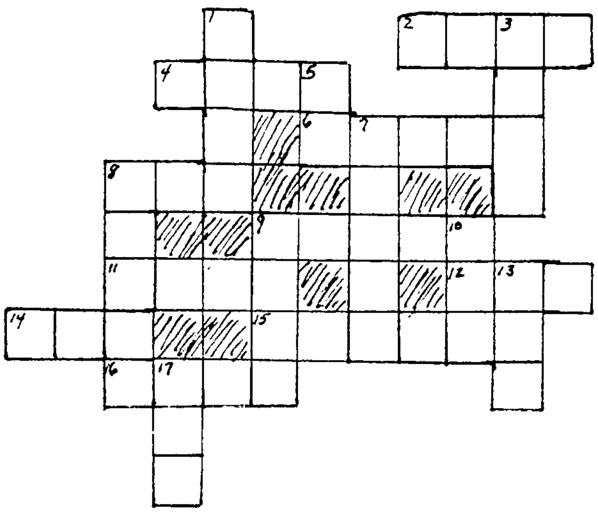
DOWN

1. A tube ____ has no mouth.
2. These vent animals have 10 legs.
4. Place where warm or hot water flows into the sea.
7. Some vent water is over 700° F. That's ___! (not cold)

Extreme Deep Wordplay

CROSSWORD PUZZLE

GRADES 4 - 6
Ocean secrets revealed



ACROSS

2. This molten rock erupts from volcanoes.
4. El _______; See 15 across.
6. Name of one ROV.
8. Some parts of the seafloor are covered with this gooey stuff.
9. *Alvin* is a deep ______; Also a scuba _____ carries a tank of air.
11. Scientists were surprised to find so much ______ at hydrothermal vents.
12. *Alvin* doesn't have any feet but does have a manipulator _____.
14. There's no light in the deep sea so it's hard to _____ what's down there.
15. A warm-water current that alters the weather; also, "the child" in Spanish.
16. After the *Titanic* hit an iceberg it sank and became a _____ wreck.

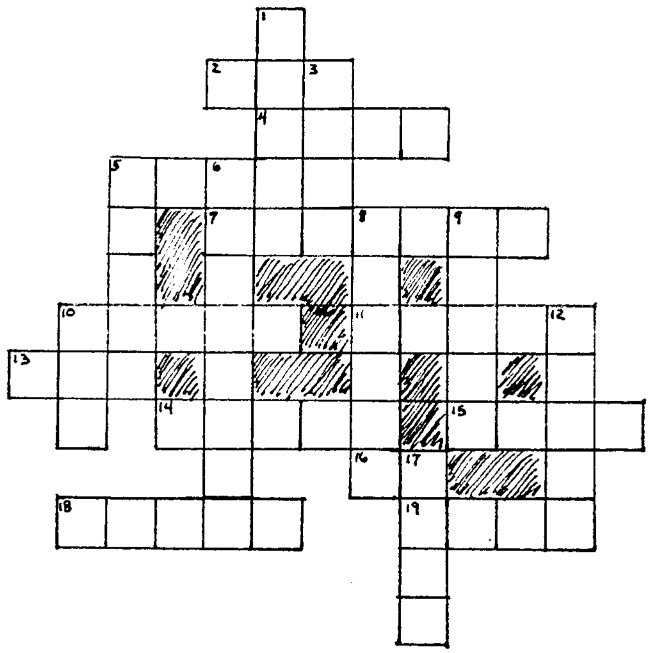
DOWN

1. When the ____ blows, it causes currents and waves.
3. Crack in the seafloor where warm or hot water flows into the cold ocean.
5. After 8 hours in *Alvin* you might be thirsty for a glass of this citrus drink (abbreviation).
7. A famous small sub that carries people deep into the sea and helped discover the *Titanic.*
9. Weird fish live in the _____ sea; opposite of shallow.
10. Past tense for run.
13. Remotely Operated Vehicle (abbreviation).
17. Sometimes vent water is so _____ it melts scientific equipment.

Extreme Deep Wordplay

CROSSWORD PUZZLE

GRADES 7 - 9
Deep-sea discoveries

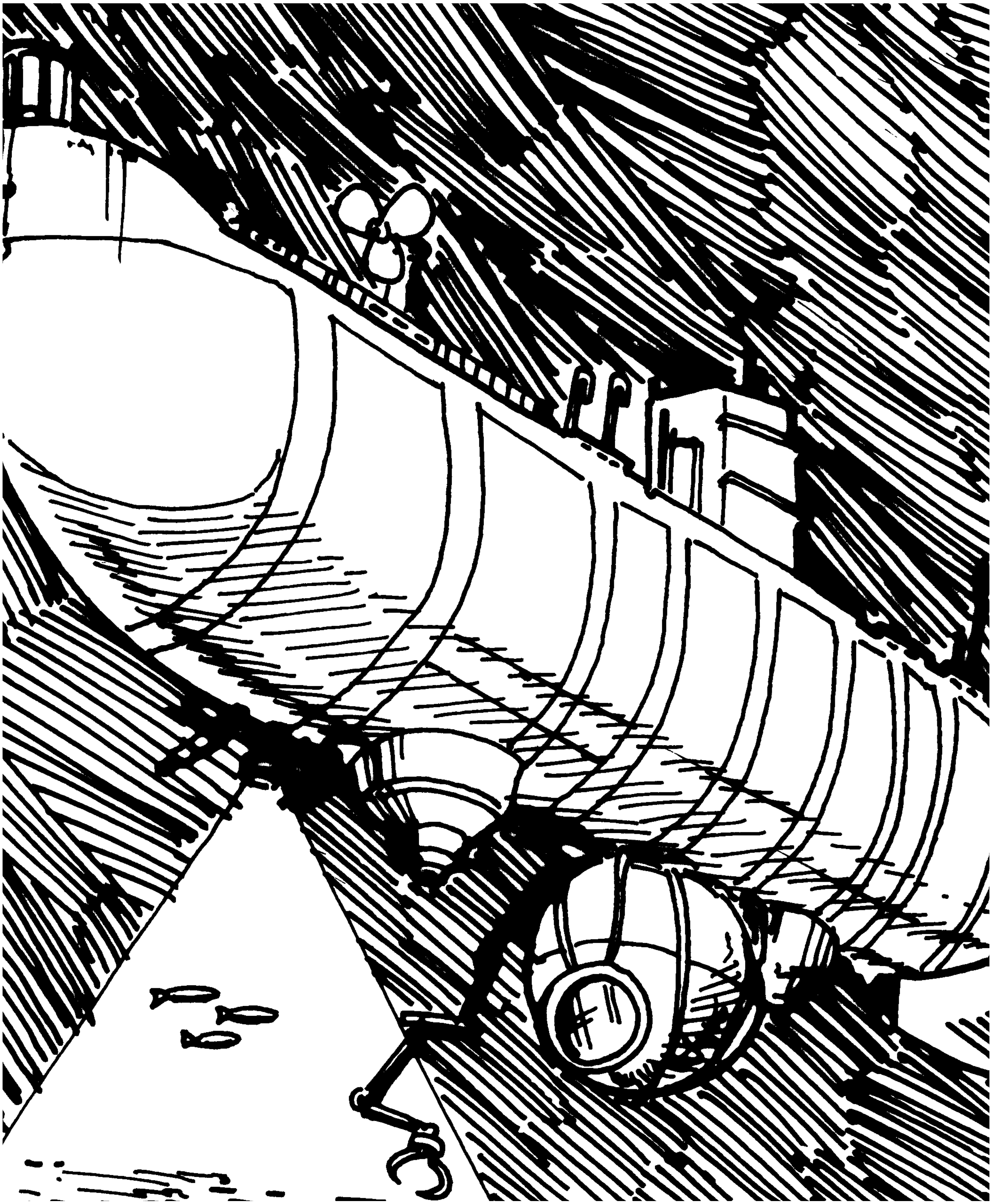


ACROSS

2. Jason is an example of an ___.
4. A collision with an ice____ sank the *Titanic.*
5. Name of an ROV.
7. Lights _______ some deep-sea creatures but scare others away.
10. Name of the oldest working submersible.
11. A heavy mineral load gives _____ smokers their name.
13. You'd need a lot of money to ___ an AUV.
14. The person who drives *Alvin* is called this.
15. A large boat; also ____ wreck.
16. Southwest (abbreviation)
18. These flotation devices support oceanographic equipment.

DOWN

1. Because it can be programmed to work on its own, an AUV is like a _____.
3. Place where hot water flows into the ocean.
5. A squishy midwater animal, often with stingers; a _____fish.
6. Word for the salt content of water.
8. Plural of 1 down.
9. These 10-legged animals are common at vent sites.
10. Short for Autonomous Underwater Vehicle.
12. Whale food.
14. Same as 14 across.
17. Tube ____; a vent animal with no mouth or gut.
19. Not quite round.

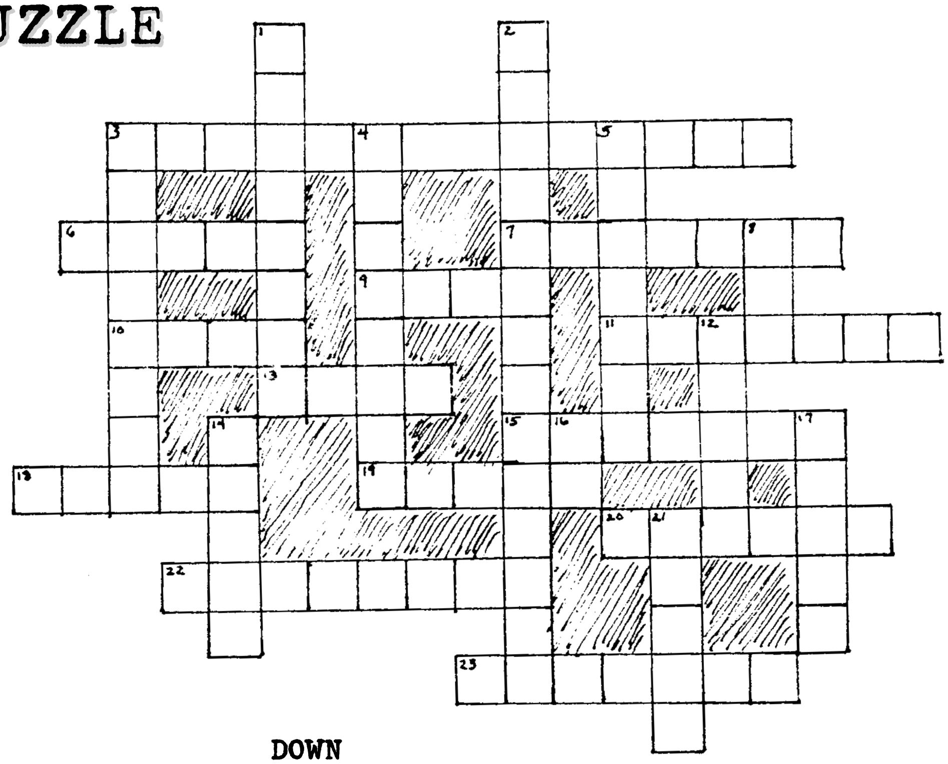


Extreme Deep Wordplay

CROSSWORD PUZZLE

Grades 10-12

What does it take to explore the deep sea?



ACROSS

3. Animals that emit light are said to be this.
6. About 70% of the Earth is covered by this.
7. A deep-sea animal named for its paddle-shaped body.
9. Deep-sea animals sense bioluminescence with these.
10. To give off, as in light.
11. Region of the Pacific where the Galapagos Rift and 9° North vents sites are found.
13. 365 1/4 days.
15. Famous shipwreck that was identified by the submersible *Alvin*.
18. Device that's dragged behind a ship to collect organisms.
19. This sense may help shrimp see vents along the Mid-Atlantic Ridge.
20. Gulf ______, a current in the Western Atlantic Ocean.
22. *Alvin's* mother ship.

DOWN

1. Salt content of water.
2. Process of turning chemicals into food.
3. Microscopic producers of hydrothermal vent communities.
4. Vent water contains these earthly compounds.
5. A stream of water set in motion by wind or differences in temperature or salinity.
8. Because *Alvin's* cockpit is so small you have to ___ rather than stand.
12. This technology uses sound to "see" through water.
14. The theory of _____ tectonics explains the shifting of continents over time.
16. Remus isn't a he or a she but an __.
17. These vent bivalves harbor chemosynthetic bacteria in their gills.
21. _____ wave is a common name for 23
23. Correct name for a giant wave that often follows an earthquake.

WORD SEARCH

What can you discover in the sea?

F	B	J	E	W	O	O	D	S	H	O	L	E	Y
R	C	H	C	A	I	A	T	A	N	T	O	T	P
B	R	S	A	I	T	H	G	I	L	U	I	N	W
I	E	D	F	R	Q	U	K	P	T	U	H	K	T
M	G	G	R	E	R	B	E	N	S	A	J	M	K
Q	N	U	U	T	O	E	T	U	I	V	N	L	R
A	E	L	S	C	D	E	M	G	L	V	H	I	N
M	L	F	G	A	X	E	L	W	G	X	L	F	C
E	L	S	P	B	R	M	Y	L	L	E	J	A	Z
S	A	T	E	M	P	E	R	A	T	U	R	E	T
U	H	R	O	K	C	E	R	W	P	I	H	S	S
I	C	E	P	C	N	N	O	S	A	J	G	U	R
E	S	A	L	I	N	I	T	Y	D	D	M	E	R
C	F	M	I	D	W	A	T	E	R	F	A	N	Y

DEEP-SEA WORD LIST

Alvin
bacteria
Challenger
deep
Gulf Stream
ice
JASON
jelly
light
midwater
Remus
salinity
shipwreck
surface
temperature
Titanic
Woods Hole

OTHER WORDS

air
bee
gun
Oahu
rod
rug
surf
tot

Answer Sheets

SCAVENGER LIST

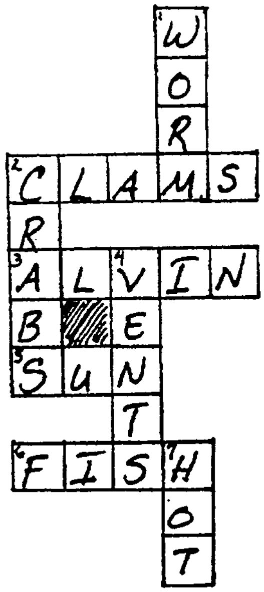
(These represent possible answers; your students may come up with others)

Find an everyday object on land that....

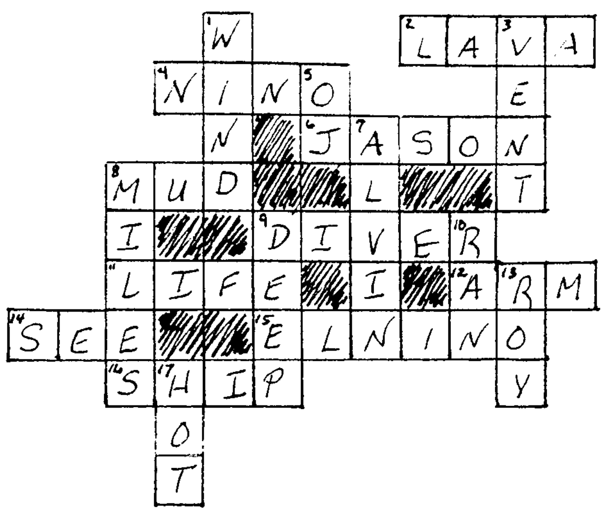
1. bioluminesces *(firefly)*
2. might smell like a hydrothermal vent *(a rotten egg)*
3. is rich in minerals *(spinach, vitamin pill or other iron- or magnesium-rich items)*
4. has the same food-chain role as chemosynthetic bacteria *(grass, flowers)*
5. is related to a deep-sea shrimp *(sow bug, any insect)*
6. would definitely change size or shape with an increase of pressure *(Styrofoam(tm) cup, anything with air spaces)*
7. would not change size or shape with an increase of pressure *(a marble, any solid object or liquid-filled object)*
8. is the one thing you'd definitely want if you were to take a dive in *Alvin (any answer okay)*
9. could help you track ocean currents *(plastic floats, tennis shoe, capped bottle)*
10. uses chemical energy to produce something *(light stick, battery, LED display)*
11. has the same kind of relationship as tubeworms and chemosynthetic bacteria *(any two organisms with a symbiotic relationship: sea anemone and anemone fish, bees and flowers)*
12. that a deep-sea oceanographer would have in his or her shipboard lab *(notebook, test tube, sample jar, waterproof paper, permanent pen, reference book)*
13. is always in the dark *(blind cave fish, developing film)*
14. uses color for protection *(leopard, inch worm)*
15. no explorer would want to leave home without *(compass, notebook, food)*
16. has the same consistency as a deep-sea jelly *(Jell-O™, water balloon)*
17. resembles the plates of Earth's crust *(puzzle)*
18. has the same food-chain role as a vent crab *(snail, cow or any other grazer)*
19. has the same texture that you imagine deep-sea mud has *(silk scarf, velvet)*
20. has something in common with the AUV Remus *(VCR or other programmable electronic or mechanical device)*

Answer Sheets

What lives at vents?

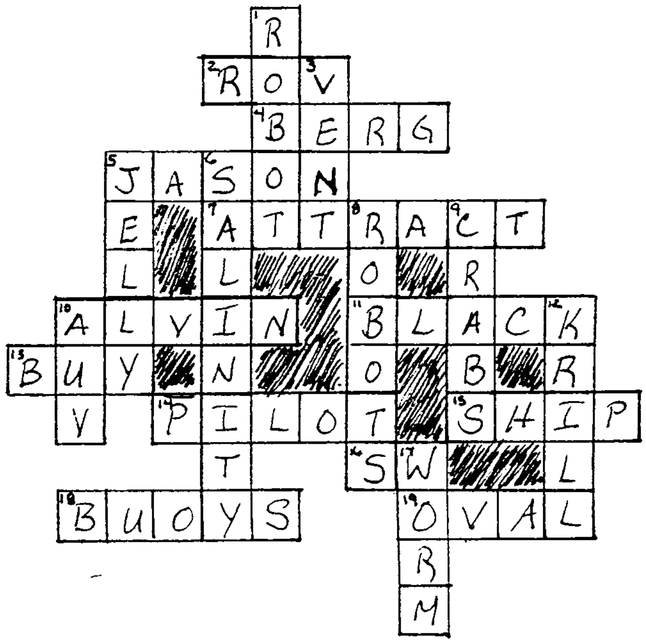


Ocean Secrets Revealed

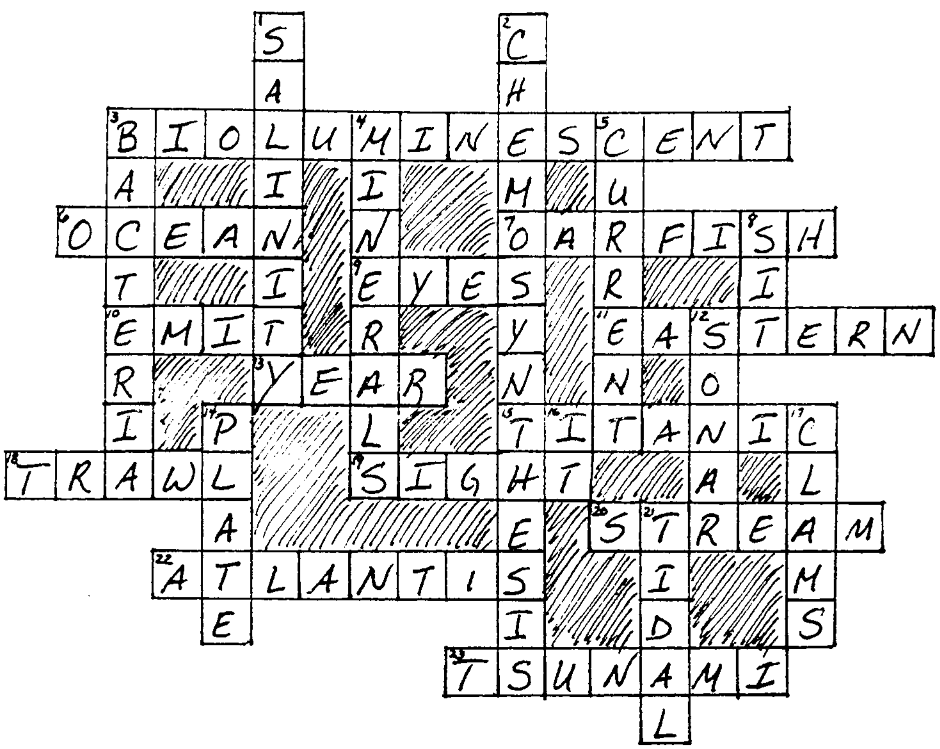


Answer Sheets

Deep Sea Discoveries



What"s it take to explore the deep sea?



WORD SEARCH

What can you discover in the sea?

F	B	J	E	W	O	O	D	S	H	O	L	E	Y
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B	R	S	A	I	T	H	G	I	L	U	I	N	W
I	E	D	F	R	Q	U	K	P	T	U	H	K	T
M	G	G	R	E	R	B	E	N	S	A	J	M	K
Q	N	U	U	T	O	E	T	U	I	V	N	L	R
A	E	L	S	C	D	E	M	G	L	V	H	I	N
M	L	F	G	A	X	E	L	W	G	X	L	F	C
E	L	S	P	B	R	M	Y	L	L	E	J	A	Z
S	A	T	E	M	P	E	R	A	T	U	R	E	T
U	H	R	O	K	C	E	R	W	P	I	H	S	S
I	C	E	P	C	N	N	O	S	A	J	G	U	R
E	S	A	L	I	N	I	T	Y	D	D	M	E	R
C	F	M	I	D	W	A	T	E	R	F	A	N	Y

DEEP-SEA WORD LIST

Alvin
bacteria
Challenger
deep
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jelly
light
midwater
Remus
salinity
shipwreck
surface
temperature
Titanic
Woods Hole

OTHER WORDS

air
bee
gun
Oahu
rod
rug
surf
tot

Glossary

abyss	deepest part of the ocean
abyssal plain	flat region in the deepest depths of the ocean
bioluminescent	describes something that produces light through chemical means
black smoker	type of hydrothermal vent whose vent water is stained dark by the many minerals it contains
canyon	a gorge
chemosynthesis	the process of producing energy by metabolizing chemicals
conclusion	a determination; an end result
consumer	organism that eats another organism
continental rise	the gentle slope of a seafloor that rises toward the continental slope
continental shelf	gently sloping section of the seafloor between the shoreline and the continental slope; the submerged part of a continent
continental slope	region of the seafloor from the outer edge of the continent to the deep-seafloor
decomposer	organism that break down non-living organic matter, releasing nutrients back into the ecosystem
ecosystem	living and non-living parts of the environment that are found in one place
expedition	a voyage for a particular purpose, such as to study the deep sea
food chain	model that describes all organisms in an ecosystem as producers, consumers and decomposers
habitat	place where an organism lives; home
hydrothermal vent	area where warm or hot, mineral-rich water flows through cracks in the seafloor; an undersea hot spring
hypothesis	an idea or theory to be tested
inference	a possible reason that explains an observation
magma	molten rock
metabolize	to perform physical and chemical changes for the maintenance of life
mid-ocean ridge	volcanic mountain range associated with seafloor spreading centers
mineral	a natural substance with a specific chemical make-up, crystal structure, color and hardness
mollusk	type of organism that has a shell
observation	making a note of something you see
ocean basin	section of the seafloor beyond the continental rise
organism	a living thing
photophore	a type of cell that produces light via chemical means
photosynthesis	process by which plants convert water and carbon dioxide to sugars using energy from the sun

plates	rigid pieces of the earth's crust that cover the earth's mantle
plate tectonics	theory that explains the movement of plates in the earth's crust over time
predator	plant or animal that captures another animal for food
prey	animal that's captured and eaten by another animal
producer	organism that produces its own food by photosynthesis or chemosynthesis
seafloor spreading	process by which undersea volcanic eruptions add to the earth's crust resulting in a movement of the crust away from the eruption site.
seamount	undersea volcano
sounding	a measurement of water depth
sulfide	any of a group of molecules that include one or more sulfur atoms
surface current	stream of water that moves along the ocean's surface
symbiosis	a relationship between two organisms that live closely together where at least one of the organism benefits
trawl	a large net or bucket-like device towed along the seafloor to collect organisms living there
trench	a deep section of the seafloor formed where two plates of the earth's crust meet, forcing one below the other.
volcano	a place in the earth's crust through which molten lava and gases erupt
SONAR	system that uses sound waves reflected off objects to determine their size and shape. Sonar stands for Sound Navigation Ranging.
tidal wave	see tsunami
tsunami	a large ocean wave caused by an underwater volcanic eruption or earthquake
rogue wave	an unusually large, unexpected wave
thermohaline current	stream of water caused by differences in temperature or salinity of two colliding water masses

CURRICULUM RESOURCES FROM

Turnstone Publishing Group, Inc./Steck-Vaughn Company

Acerno, Karen. Off To Sea; An inside look at a research cruise; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
http://www.offtosea.turnstonepub.com

Resources

Stevens, Betsy, and Amy Pallant. Dive to the Deep Ocean; Voyages of exploration and discovery; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
http://www.divedeepocean.turnstonepub.com

Stevens, Betsy Franz. Down to a Sunless Sea; The strange world of hydrothermal vents; Teacher's Resource Binder. Austin, TX: Steck-Vaughn Company and Turnstone Publishing Group, Inc., 1999.
http://www.vents.turnstonepub.com

READING LIST AND REFERENCES

Books

Broad, William J. The Universe Below: Discovering the secrets of the deep sea. New York, New York: Simon & Schuster, 1997.

Cone, Joseph. Fire Under the Sea. New York: William Morrow, 1991.

Cornell, Joseph. Sharing Nature with Children. Ananda Publications, 1979.

Ellis, Richard. Deep Atlantic: Life, Death and Exploration in the Abyss. First ed. New York; Alfred A. Knopf, 1996.

Fodor, R.V. The Strange World of Deep Sea Vents. Springfield, NH: Enslow, 1997.

Gross, M. Grant. Oceanography: A view of the Earth. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1972.

Kaharl, Victoria A. Water Baby: The story of Alvin. New York: Oxford University Press, 1990.

Kneidel, Sally Stenhouse. Creepy Crawlies and the Scientific Method: Over 100 hands-on science experiments for children. Golden, CO: Fulcrum Publishing, 1993.

Lowery, Lawrence F. The Everyday Science Sourcebook. Boston: Allyn and Bacon, Inc. 1978.

Ranger Rick's Nature Scope. Diving Into Oceans. Saltwater Wonders (Ranger Rick) handout.

Van Dover, Cindy Lee. The Octopus's Garden. Menlo Park, CA: Helix Books, Addison-Wesley Publishing Company, 1996.

Magazine Articles

"Following the track of 80,000 wet Nikes." Science News, Sept. 19, 1992. p. 189.

"Deep-sea currents driven by wind." Science News, August 31, 1985. p. 141.

Smith, Walter H. OF., David T. Sandwell. 1997. "Global seafloor topography from satellite altimetry and ship depth soundings." Science 277: 1956-1962.

Videos

Deep Sea Dive. National Geographic Society.

Websites

Woods Hole Oceanographic Institution
http://www.whoi.edu
Volcano World
http://volcano.und.edu

American Museum of Natural History Expeditions
http://www.amnhonline.org/expeditions/blacksmokers

Axial Seamount Volcanic Event, January, 1998
http://newport.pmel.noaa.gov/axial98.html

Vents Program
http://www.pmel.noaa.gov/vents/home.html

Mixing Zephyr Reflections: The virtual logbook of an oceanography student at sea
http://www.neis.net/zephyr/

RIDGE
http://ridge.unh.edu

Bibliograpy of CCE Publications

Microbes: Invisible Invaders, Amazing Allies Teacher's Activity Guide. Text by WordCraft, Monterey, CA. Illustrations by Kerry Ferguson, San Antonio, TX. Design by Bradford Lawton Design Group, San Antonio, TX © 1997.

Africa: One Continent. Many Worlds. Activity Guide. The Field Museum, Chicago, IL. © 1993.

The Robot Zoo: A Teacher's Guide to the way animals work. Text by WordCraft, Monterey, CA. Illustrations by Kerry Ferguson, San Antonio, TX. Design by Molly Castor, Silicon Graphics, Inc. © 1997.

Educator's Activity Book about Bats. Bat Conservation International, Austin, TX. © 1991.

Theme Park: The Art & Science of Universal Studios Islands of Adventure Teacher's Activity Guide. Text by WordCraft, Monterey, CA. © 1999.

Extreme Deep: Mission to the Abyss Teacher's Activity Guide. Text by WordCarft, Monterey, CA. Illustrations by Kerry Ferguson, San Antonio, TX. Design by Rose Davis, San Antonio, TX.

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