



## OCEAN EXPLORATION LESSON PLAN

# Exploring Explorations

### Theme

Ocean Exploration

### Links to Overview Essays and Resources Needed for Student Research

<http://oceanservice.noaa.gov/topics/oceans/oceanex/>

### Subject Area

Life Science/Physical Science/Earth Science

### Grade Level

9-12

### Focus Question

What discoveries and human benefits have resulted from exploration of the Earth's deep oceans?

### Learning Objectives

- Students will be able to describe at least three human benefits that have resulted from explorations of the Earth's deep oceans.
- Students will be able to identify separate examples of Ocean Exploration expeditions focussed on historical, biological, and physical features of the Earth's deep oceans.

### Materials Needed

- Copies of "Ocean Exploration Worksheet," one copy for each student or student group
- Chalkboard, marker board, or overhead projector to list discoveries and potential benefits associated with Ocean Exploration expeditions
- (optional) Computers with internet access; if students do not have access to the internet, download copies of materials cited under "Learning Procedure" and provide copies of these materials to each student or student group

### Audio/Visual Materials Needed

- (optional) Equipment for viewing on-line video tours of deep-sea communities

### Teaching Time

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

### Seating Arrangement

Classroom style or groups of 2-3 students

### Maximum Number of Students

30

### Key Words

Ocean exploration  
Cold seep communities  
Hydrothermal vents  
Methane hydrates  
Bioprospecting  
Shipwreck  
Anthropology

### Background Information

In the past twenty years, new tools and technologies have allowed scientists to visit many previously unexplored areas of the deep ocean. These expeditions have discovered hundreds of new species, and even new ecosystems, but many more discoveries are yet to be made.

The National Oceanic and Atmospheric Administration (NOAA) created the Office of Ocean Exploration to learn more about unexplored areas in the Earth's oceans. Expeditions sponsored by the Office of Ocean Exploration have:

- Explored recently discovered hydrothermal vents and cold seep communities that have resulted in new ideas about the beginnings of life on earth;
- Prospected for new anti-cancer drugs from the deep sea;
- Investigated methane hydrate deposits that may be an energy source twice as large as all global reserves of coal, oil, and conventional natural gas combined (the same methane hydrate deposits may also produce disastrous tsu-

namis (“tidal waves”), and may have been responsible for the Paleocene extinction event);

- Recovered the historic turret and engine of the Civil War ironclad, *USS Monitor*;
- Discovered well-preserved 19th century shipwrecks in the Thunder Bay National Marine Sanctuary in Lake Huron, Michigan;
- Investigated origins and culture of the first people to inhabit North America; and
- Discovered the Steamship *Portland*, an ill-fated passenger ship lost in 1898 off the Massachusetts coast.

Videos, photography, personal logs, and mission details from more than forty expeditions can be found at <http://oceanexplorer.noaa.gov/explorations/explorations.html>. This lesson is intended to introduce students to the variety of expeditions conducted by the Ocean Exploration program and the discoveries that have resulted from these expeditions.

### Learning Procedure

1.

Briefly review some of recent discoveries associated with deep ocean explorations. You may want to visit the Ocean Explorer Gallery (<http://oceanexplorer.noaa.gov/gallery/gallery.html>), the Magic Mountain Virtual Site (<http://oceanexplorer.noaa.gov/explorations/02fire/logs/magicmountain/>), and/or virtual tours of hydrothermal vent and cold seep communities (<http://www.bio.psu.edu/hotvents> and [http://www.bio.psu.edu/cold\\_seeps](http://www.bio.psu.edu/cold_seeps), respectively). Be sure students understand that a great deal of the Earth’s deep ocean remains unexplored.

2.

Have each student or student group complete the “Ocean Exploration Worksheet.” You may want to assign a specific expedition to each student or student group and have them present a brief report on the Expedition and its results. Lead a discussion of their results. Keep a running list of new discoveries and potential benefits. Students should realize that expeditions to unexplored areas almost routinely discover new species, and that bottom dwelling species have proven to be an extremely promising source for powerful new treatments for cardiovascular disease, cancer, inflammatory dis-

eases, and infections. Other benefits include discovery of new energy sources; information on natural hazards such as volcanoes, earthquakes, and tsunamis; and better understanding of human history and the origins of life on Earth.

**Correct answers to the Worksheet questions are:**

1. In what two seas did a 2004 international Ocean Exploration Expedition investigate global climate change? [[the Bering Sea and Chukchi Sea](#)]
2. What type of deep-sea community was studied by the Windows to the Deep Expedition? [[methane seeps](#)]
3. What is the world's least explored ocean? [[the Arctic Ocean](#)]
4. Where were deep-sea hydrothermal vents first discovered 25 years ago? [[Galapagos Rift](#)]
5. How are aquaculture and cell culture relevant to the 2003 Deep Sea Medicines Expedition? [[aquaculture and cell culture provide methods for producing useful chemicals from deep sea organisms without damaging the ecosystem or depleting natural populations](#)]
6. What was the habitat of mussels and other deep-sea animals studied by the Gulf of Mexico Deep Sea Biology Expedition? [[cold seeps](#)]
7. Where is the "Submarine Ring of Fire"? [[the Mariana Arc](#)]
8. What kind of communities were studied by the 2004 Mountains in the Sea Expedition? [[octocoral](#)]
9. What are the "Mountains in the Sea?" [[the New England Seamounts](#)]
10. The 2004 Gulf of Alaska 2004 focussed on what geological features? [[submerged volcanoes](#)]
11. Who burned the British warship *Gaspee*? [[disgruntled Amercian colonists](#)]
12. What is one possible use for polarization vision investi-

gated by Operation Deep Scope? [[signaling and communication](#)]

13. Part of the 2004 Estuary to the Abyss Expedition was concerned with antimicrobial resistance. What has been identified as a source of antimicrobial resistance in microbes [inappropriate use of antimicrobials], and what are “nosocomial” infections? [[Infections with antimicrobial-resistant microbes in a hospital or hospital-like setting](#)]
14. On May 21, 2002, the Davidson Seamount Expedition posted a video of an animal sighted at 1,725 m that had previously been sighted only once. What was the animal? [[a halosaur](#)]
15. During the 2002 Arctic Exploration Expedition, one scientist – Mike Vechionne – discussed similarities and differences between the Arctic and Antarctic. One difference he noted was that it is common to see seals hauled out among the penguins on Antarctic ice floes, but none were seen on floes in the Arctic. Why? [[Because there is a major difference in the predators of the two regions. The top predators of the Antarctic, leopard seals and killer whales, dwell below the water surface. In the Arctic, the apex predator is the great white bear prowling on the ice floes. Seals don't usually haul out in the Arctic because they are avoiding the bears.](#)]
16. The Life on the Edge 2004 Expedition included explorations of deep coral ecosystems that are severely threatened by a variety of human activities. What is the dominant coral species in these ecosystems? [[Lophelia pertusa](#)]
17. The Gulf of Mexico was ideal for the WW II Shipwreck Survey Expedition because of the number of ships that were casualties of World War II. How many Allied vessels were sunk in the Gulf by German U-boats in 1942 and early 1943? [[56](#)]
18. Scientists participating in the 2002 Exploring Alaska's Seamounts expedition noticed that most of the giant spider crabs (*Macroregonia macrocheira*) viewed from the submersible *Alvin* were missing limbs, and had a black scar (blas-

tema) where a limb once existed. They also noticed that almost all of the limbs were lost at the base of the limb. What did this suggest to the scientists? [that limb loss was voluntary (autotomy); perhaps once grabbed, the crabs release their limbs to escape an enemy's grip]

19. On August 10, 2003, scientists on the Charleston Bump Expedition discovered an animal that one observer said "looked like interactive art!" What was this animal? [a Syllid polychaete worm]
20. What caused the Steamship *Portland* to sink? [a massive storm off the coast of New England]
21. What was the most effective method for collecting adult flying fishes used by the 2003 Life on the Edge Expedition? [dip netting at night with bright lights]
22. Kick'em Jenny Volcano is the most active underwater volcano in what region? [the West Indies]
23. On September 28, 2003, the Gulf of Mexico Habitats Expedition collected a beautiful flower-like animal. But the log entry for the day says that this beauty is deceiving. Why? [because the animal was the berried sea anemone *Alicia mirabilis*, the most toxic anemone in the Western Hemisphere]
24. The 2003 Puerto Rico Trench Expedition explored the deepest part of the Atlantic Ocean. How deep is it? [almost 8,400 m (5.2 miles)]
25. The Puerto Rico Trench Expedition also discovered a large underwater fault system similar to the San Andreas Fault in California. Where is this fault located? [Bunce Fault is located 115 km north of Puerto Rico]
26. What conditions in the Black Sea make it ideal for preserving ancient wooden shipwrecks? [cold water, and the almost complete absence of oxygen below a few hundred meters (a unique feature of the Black Sea)]
27. On September 25, 2001, The R/V *Alvin* made its first dive

on the Blake Ridge. What unusual live samples were brought up from the deep ocean floor? [giant mussels]

28. During the 2003 Northwestern Hawaiian Islands Expedition, a tagged monk seal peered into the porthole of the Pisces deep-sea manned submersibles at what depth? [more than 500 m]
29. What percentage of all U.S coral reefs are located in the Northwestern Hawaiian Islands? [about 70%]
30. Where is the wreck of the German U-boat 166? [the U-166 rests in 5,000 ft of water about 50 mi southeast of New Orleans, and is the only U-boat sunk in the Gulf of Mexico]
31. One of the studies conducted as part of the Titanic 2004 Expedition involved tiny microbes that feed on iron and create icicle-shaped formations called \_\_\_\_\_. [rusticles]
32. According to the last mission log (June 19) of the 2002 Sanctuary Quest Expedition, how many humpback whales were sighted during the expedition in the Olympic Coast National Marine Sanctuary? [139; the highest number recorded on a Sanctuary research cruise]
33. What was the important discovery made on July 11, 2002, by explorers on the Monitor Expedition 2002? [one of the 16,000-pound cannons was discovered inside the Monitor's gun turret]
34. October 8, 2002, scientists on the Gulf of Mexico Expedition found a bivalve clam that was identified as *Acesta excavata*. What was unusual about this discovery? [*Acesta excavata* is found only in the northeast Atlantic; either this species has a much larger range, or a close relative (possibly a new species) was discovered]
35. The June 28 log of the 2001 Lewis and Clark Legacy Expedition comments on an advantage of using an ROV for underwater exploration. What is this advantage? [a geologist, ichthyologist, invertebrate zoologist and physical oceanographer can all see the bottom at the same time,

allowing scientists with differing expertise to share ideas as the action is happening.]

### The Bridge Connection

[www.vims.edu/bridge](http://www.vims.edu/bridge) – In the “Site Navigation” menu on the left, click “Professional Development,” then “Lesson Plans,” then “Secondary & Middle” for links to sites with curriculum units and large collections of lesson plans and/or classroom activities.

### The Me Connection

Have students write a brief essay describing at least three ways in which exploration of Earth’s deep oceans could be of direct personal benefit.

### Extensions

1. Visit <http://oceanexplorer.noaa.gov/edu/lessonplans/lessonplans.html> for more than 150 lesson plans and activities based on Ocean Exploration expeditions.
2. Many Ocean Explorer expeditions use various types of manned or remotely operated underwater vehicles. Students can learn the underlying principles by building their own operating underwater vehicles with plans provided in books by Harry Bohm and Vickie Jensen (see “Resources”).

### Resources

<http://oceanservice.noaa.gov/topics/oceans/oceanex/> – National Ocean Service Web page introducing the Ocean Exploration program

<http://oceanexplorer.noaa.gov/> – the Ocean Explorer website

Bohm, H. and V. Jensen. 1997. Build Your Own Underwater Robot and Other Wet Projects. Westcoast Words. Vancouver, BC, Canada. 150 pp. – Build-it-yourself projects demonstrate the physical principles that are used to design and build real submarines and submersibles. For price/ordering information, contact: Westcoast Words, 3036 Waterloo Street, Vancouver, BC CANADA V6R 3J6; phone/fax: (604) 731-5565; e-mail: [vjensen@telus.net](mailto:vjensen@telus.net)

Bohm, H. and V. Jensen. 2001. Build Your Own Programmable



LEGO® Submersible. Westcoast Words. Vancouver, BC, Canada. 39 pp – A handbook for building an Autonomous Underwater Vehicle using a microcomputer such as the LEGO Mindstorms or Robolab RCX controller brick. For price/ordering information, contact: Westcoast Words, 3036 Waterloo Street, Vancouver, BC CANADA V6R 3J6; phone/fax: (604) 731-5565; e-mail: [vjensen@telus.net](mailto:vjensen@telus.net)

Bohm, H. and V. Jensen. Introduction to Underwater Vehicle Design. A textbook designed for advanced high school or college-level courses. The text features complete plans for an inexpensive, shallow-water ROV. For information on prices and how to order, contact the Marine Advanced Technology Education Center at [info@marinetech.org](mailto:info@marinetech.org).

### National Science Education Standards

#### Content Standard A: Science as Inquiry

- Understandings about scientific inquiry

#### Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

#### Content Standard F: Science in Personal and Social Perspectives

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

#### Content Standard G: History and Nature of Science

- Science as a human endeavor

### Links to AAAS “Oceans Map” (aka benchmarks)

5D/H1 – Ecosystems can be reasonably stable over hundreds or thousands of years. As any population of organisms grows, it is held in check by one or more environmental factors: depletion of food or nesting sites, increased loss to increased numbers of predators, or parasites. If a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in

stages that eventually results in a system similar to the original one.

5D/H2 – Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.

5D/H3 – Human beings are part of the earth’s ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.



## OCEAN EXPLORATION WORKSHEET

**Ocean Exploration Subject Review**

These questions are your guide to a quick “treasure hunt” through the Ocean Exploration website. Begin with the Ocean Explorer Explorations webpage at <http://oceanexplorer.noaa.gov/explorations/explorations.html>. Some questions can be answered directly from this web page. To find answers for the rest, you will need to follow the links to pages for specific expeditions. Happy exploring!

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