Exploring LIVE with the NOAA Ship *Okeanos Explorer*

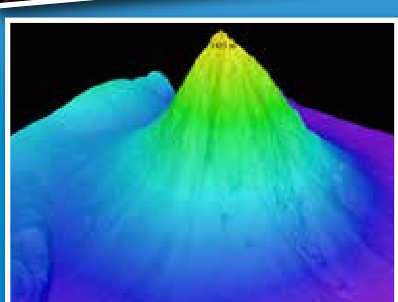

Image captions/credits on Page 2.

lesson plan

Grade Level
5-12 (Physical Science/Earth Science)

Focus Question
How can students become active ocean explorers while viewing live video feeds during *Okeanos Explorer* expeditions?

Learning Objectives
- Students learn how to access the *Ocean Explorer* website and access a live video feed of an *Okeanos Explorer* expedition.
- Students explore along with the ocean science community via live feeds during *Okeanos Explorer* expeditions. This may include listening to explorers communicating with one another from the ship and at remote locations on land, seeing discoveries take place via live video, or seeing bathymetric data as it is being processed in the ship's control room.
- Students learn how to track an expedition using the *Okeanos* Atlas.

Audio-Visual Materials
- ❑ Computer(s) with Internet access

Teaching Time
Variable

Seating Arrangement
Variable

Maximum Number of Students
Variable

Key Words
NOAA Ship *Okeanos Explorer*
Ocean Exploration
Remotely Operated Vehicle (ROV)
Telepresence
Bathymetry

Background Information
The NOAA Ship *Okeanos Explorer* was commissioned as "America's Ship for Ocean Exploration" in 2008 and is the only U.S. ship whose sole assignment is to systematically explore Earth's largely unknown ocean.

As a ship of discovery, her mission is to find anomalies; things that are unusual and unexpected. Since Earth's ocean is 95% unexplored, the mission of the *Okeanos Explorer* encompasses a very large geographic area. Each year, groups of ocean explorers representing a broad cross-section of the oceanographic community meet to determine important locations for exploration and, from this meeting, sites of primary interest are strategically selected for the year's operations.

Frequently, during expeditions live video feeds are provided over the internet as the *Okeanos Explorer* travels to these selected regions looking for anomalies. Sometimes the ship's primary goal is mapping a previously unexplored area and other times it may be viewing details of an area with a remotely operated vehicle (ROV). Depending on the expedition, those watching the live feed may see false color bathymetric data as the multibeam sonar system maps the ocean floor, or they may be virtually participating in the exploration of extreme habitats with live video from the ROV. Underwater robots with their high definition cameras and lighting are our eyes into Earth's deep, dark ocean. As digital imaging technology continues to improve, views through "robot eyes" become ever more beautiful and fascinating (see, for example, http://oceanexplorer.noaa.gov/okeanos/media/slideshow/flash_slideshow.html and http://oceanexplorer.noaa.gov/okeanos/media/slideshow/video_playlist.html).

Satellite technology allows scientists, teachers and students on shore access to data and images from the ship at sea in real-time. This concept of access in real-time is called telepresence technology. This system provides a virtual portal into the excitement of oceanographic discoveries and demonstrates the importance of exploring our largely unknown ocean.

Telepresence is simply a group of technologies that enable people to observe and interact with events at remote locations. On board the NOAA Ship *Okeanos Explorer*, the foundation for telepresence is advanced broadband satellite communication. Telepresence allows video, still imagery and audio from sea to be transmitted in real time through satellites to a facility at the University of Rhode Island called the Inner Space Center (ISC). From the ISC, these products are transmitted through the Internet to other scientists ashore located at Exploration Command Centers (ECCs). The ECCs are remote locations outfitted with special communications equipment, including consoles with plasma screens for viewing the video, as well as an Internet-enabled intercom system. The system enables scientists and others to converse simultaneously with the explorers at sea, and/or scientists at other ECCs located anywhere in the world. Additionally, the ISC manages the live feeds provided via the Internet, bringing expeditions

Images from Page 1 top to bottom:
The new 6,000-meter ROV has more sophisticated capabilities than the previous ROV used aboard the *Okeanos Explorer, Little Hercules*, and the increased capabilities will enable innovation through research and development of new sensors and systems. The new ROV currently includes hydraulic manipulator arms for deploying oceanographic sensors, an inertial navigation system, a Doppler velocity navigation system, and a system for dynamic lighting control.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1302/welcome.htm

Early morning view from the ship. The VSAT and rescue boats are visible. Image courtesy of the NOAA *Okeanos Explorer* Program.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1202/logs/hires/mar23-1-hires.jpg

ROV Team Lead, Commanding Officer, and Science Team Lead discuss operations at the Mid-Cayman Rise with participants located at both the Silver Spring ECC, and URI's Inner Space Center. Image courtesy of NOAA *Okeanos Explorer* Program, MCR Expedition 2011.
http://oceanexplorer.noaa.gov/okeanos/explorations/ex1104/logs/hires/daily_updates_aug9_1_hires.jpg

Okeanos Explorer's EM302 multibeam sonar mapping system produced this detailed image of the Kawio Barat seamount, which rises around 3800 meters from the seafloor. Image courtesy of NOAA *Okeanos Explorer* Program, INDEX-SATAL 2010.
http://oceanexplorer.noaa.gov/okeanos/explorations/10index/logs/hires/june26fig1_hires.jpg

into classrooms and living rooms in real time. During expeditions the internet audience will often hear narration by a few scientists in the control room of the ship and scientists based at ECCs in various places around the world.

For more information on these technologies and the many disciplines of scientific expertise aboard the ship, including engineers and survey technicians, see the 2012 issue of *Current*, the Journal of Marine Education. http://oceanexplorer.noaa.gov/edu/oceanage/current.html.

Learning Procedure

This lesson provides suggestions on how educators can make the best instructional use of live feeds during *Okeanos Explorer* expeditions. The order of these steps is flexible. Educators may consider various methods to prepare students before an expedition takes place to get the most of the live feed time. This may include introducing key concepts such as multibeam sonar or the use of remotely operated vehicles, working through the *Okeanos* Atlas lesson described below to learn to track the ship in real time, and other options listed below.

1. Explain to students that in the next few days, they will be looking at video streaming live from the NOAA Ship *Okeanos Explorer* during an expedition. Expedition information online includes mission logs, daily updates, dive videos, lessons, images, and much more. The *Okeanos Explorer* Expedition webpage is http://oceanexplorer.noaa.gov/okeanos/explorations/explorations.html

2. Introduce students to the NOAA Ship *Okeanos Explorer*, saying that it is the only federal vessel solely dedicated to exploring the ocean. To fulfill its mission, the *Okeanos Explorer* has specialized capabilities for finding new and unusual features in unexplored parts of Earth's ocean, and for gathering key information that will support more detailed investigations by subsequent expeditions. These capabilities include:
   - Underwater mapping using multibeam sonar capable of producing high-resolution maps of the seafloor to depths of 6,000 meters;
   - Underwater robots (remotely operated vehicles, or ROVs) that can investigate anomalies as deep as 6,000 meters; and
   - Advanced broadband satellite communication and telepresence.

   Visit the following website for images and more information about the ship: http://oceanexplorer.noaa.gov/okeanos/about.html.

3. Introduce the concept of telepresence by saying that it is simply a group of technologies that enable people to observe and interact with events at remote locations. On board the NOAA Ship *Okeanos Explorer*, the foundation for telepresence is advanced broadband

satellite communication. Telepresence allows video, other imagery, and audio to be transmitted in real time from a remotely operated vehicle at sea through satellites to Exploration Command Centers ashore. More information can be found at: http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-TPbkgnd.pdf.

4. Depending on the focus of the expedition, introduce your students to the tools being used to explore. These tools may include:
   Multibeam Sonar:
   http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-MMBkgnd.pdf

   Conductivity, Temperature and Depth meters (CTDs):
   http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-WCIntro.pdf

   Underwater Robots:
   http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-URintro.pdf

5. As homework prior to watching a live expedition, instruct students to work through the lesson introducing the *Okeanos* Atlas: http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-AppendixA.pdf.

   Then, either as a class or individually in a computer lab, direct students to the *Okeanos* Atlas to find the location of the ship and the general area where it is working. http://www.ncddc.noaa.gov/website/google_maps/OkeanosExplorer/mapsOkeanos.htm. Have students go to the top left drop down menu, select the current cruise and explore the different data layers to become more familiar with the expedition path.

6. Discuss the challenges associated with making video available in real time and being able to listen to the explorers as they are working, possibly discovering an unknown shipwreck, finding gas seeps, or seeing never before seen organisms on a deep-ocean seamount. With all the technology accessible today, it is easy to forget the level of innovative technology necessary to bring video and audio up from the cold, dark depths of the ocean to living rooms and offices around the world in approximately six seconds!

7. Have students read the Mission Plan for this exploration found in the Background section of the expedition webpage.

8. If you are watching live video, ask students to be aware of how telepresence is being used, and the benefits and challenges that result from looking at live video. See the lesson "What *Little Herc*

Saw" as an extension: http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-URLittleHerc78.pdf.

If you are seeing the multibeam sonar at work, consider using one of the following lessons from the Multibeam Sonar section of the *Okeanos Explorer* Education Materials Collection, Volume 2: How Do We Explore?:

Wet Maps:
http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-MMmaps56.pdf

Mapping the Deep-ocean Floor:
http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-MMMapping78.pdf

Watching in 3D:
http://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-MM3D912.pdf

9. Pose the following guiding questions to the class, depending on what is being revealed in the video exploration:
   a. What is the depth of this expedition dive?
   b. What is the main focus of this dive (biological, archaeological, looking for vents, mapping, or a combination)?
   c. When considering the telepresence format with people in different places, can you determine the location of the person who is speaking (on shore, on the ship, on the telephone)?
   d. What types of organisms are you seeing? What level of biodiversity do you see (high, medium, low)?
   e. What kind of geological features are present (*e.g.* seamounts, trenches, rocky bottom)?
   f. Which scientific disciplines are represented among the explorers (*e.g.* engineer, biologist, chemist, geologist)?
   g. Do you think the scientists are able to get all the information (mapping, water chemistry or imagery) they want during this expedition?
   h. Given the method of exploration with Exploration Command Centers around the world, do you think we are able to gather more information than we might otherwise? In what way(s)?

10. Have students develop thoughtful questions based on their observations and use the Ask an Explorer tool on the expedition site to pose questions. Questions should be answered by the explorers in a 24-72 hour time period.

Lesson Alignment to the Next Generation Science Standards
Performance Expectations

Middle School NGSS Alignments

MS-PS4 Waves and Their Applications in Technologies for Information Transfer

Performance Expectations:

MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

Science and Engineering Practices:

Obtaining, Evaluating, and Communicating Information

- Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)

Disciplinary Core Idea:

PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)

Crosscutting Concepts:

Connections to Engineering, Technology, and Applications of Science:

Influence of Science, Engineering, and Technology on Society and the Natural World

- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)

Connections to Nature of Science

Science is a Human Endeavor

- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

Note: Additional Science and Engineering Practices and Crosscutting Concepts to target will be dependent on the content of the live feed and the direction educators choose to take with this lesson.

Common Core State Standards Connections:

ELA/Literacy –

- RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-PS4-3)
- RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-PS4-3)

High School NGSS Alignments

HS-PS4 Waves and Their Applications in Technologies for Information Transfer

Performance Expectations:

HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information. [Clarification Statement: Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.]

Science and Engineering Practices:

Asking Questions and Defining Problems

- Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. (HS-PS4-2)

Disciplinary Core Idea:

PS4.A: Wave Properties

- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. (HS-PS4-2),(HS-PS4-5)

Crosscutting Concepts:

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-PS4-2),(HS-PS4-5)
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS4-2)

Note: Additional Science and Engineering Practices and Crosscutting Concepts to target will be dependent on the content of the live feed and the direction educators choose to take with this lesson.

Common Core State Standards Connections:

ELA/Literacy –

- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS4-2),(HS-PS4-3),(HS-PS4-4)
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-PS4-1),(HS-PS4-4)

Lesson Alignment to Ocean Literacy Essential Principles and Fundamental Concepts

Essential Principle 6: The ocean and humans are inextricably interconnected.

Fundamental Concept c. The ocean is a source of inspiration, recreation, rejuvenation and discovery. It is also an important element in the heritage of many cultures.

Essential Principle 7.
The ocean is largely unexplored.

Fundamental Concept a. The ocean is the largest unexplored place on Earth—less than 5% of it has been explored. The next generation of explorers and researchers will find great opportunities for discovery, innovation, and investigation.

Fundamental Concept b. Understanding the ocean is more than a matter of curiosity. Exploration, experimentation, and discovery are required to better understand ocean systems and processes. Our very survival hinges upon it.

Fundamental Concept d. New technologies, sensors, and tools are expanding our ability to explore the ocean. Scientists are relying more and more on satellites, drifters, buoys, subsea observatories, and unmanned submersibles.

Fundamental Concept f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.

Send Us Your Feedback

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

For More Information

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Credit

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