



WATCHING IN 3D

Exploring with Multibeam Sonar



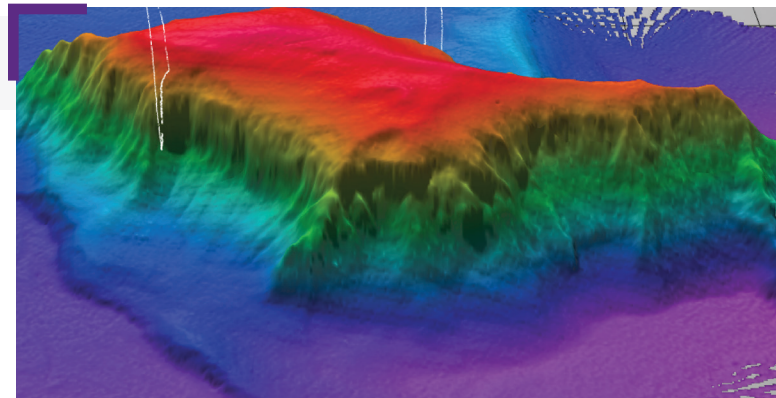
CASE STUDY 3: Exploring a Northeast U.S. Seamount (Mytilus)

What is a Seamount?

Most seamounts are remnants of extinct volcanoes. Typically, they are cone shaped, but often have other prominent features such as craters and linear ridges and some, called guyots, have large, flat summits. To be classified as a seamount the feature must have a vertical relief of at least 1,000 meters (3,300 feet) above the surrounding the seafloor.

Seamounts are found in every world ocean basin and while it is not known precisely how many seamounts there are, they are very numerous. Based on data from satellite altimetry and bathymetric mapping data obtained from survey ships, the number of seamounts that are at least 1,000 meters high is thought to be greater than 100,000. Despite their abundance, however, less than one-tenth of a percent of the seamounts in the world have been explored.

Studies conducted over seamounts indicate that they function as “oases of life,” with higher species diversity and biomass found on seamounts and in the waters around them than on the flat seafloor. They rise up high in the water column, creating complex current patterns influencing what lives on and above them. Seamounts also provide substrate (a location for attachment) where organisms can settle and grow. These organisms provide a food source for other animals. Scientists have found that seamounts often provide habitat to endemic species, or species found only in a single location.



Fledermaus 3D image of Mytilus Seamount.

Four key technologies are used to gather baseline information on areas of ocean exploration:



Listen
Multibeam sonar mapping system



Test
Conductivity, Temperature and Depth profilers (CTDs)



Photograph
Remotely Operated Vehicles (ROV)



Share
Telepresence technologies

This activity will guide you through exploration of the Mytilus Seamount within the New England Seamount Chain, using the [Ocean Exploration Digital Atlas](#) (a searchable, interactive expedition data map) and a free version of [Fledermaus](#), a powerful interactive mapping data visualization software used by ocean explorers, providing you first-hand experience using these tools to explore **multibeam sonar** capabilities in 3D. Multibeam sonar is one of the most powerful tools available for modern deep-sea exploration, and can create high-resolution maps, three dimensional models, or even “fly-through” videos that simulate a trip across an area being mapped.

This activity will also introduce you to the NOAA Office of Ocean Exploration and Research website and the [2013 Northeast U.S. Canyons Expedition](#) where Mytilus Seamount was studied.



What Northeast U.S. Seamount are We Exploring?

The New England Seamounts are a chain of extinct submarine volcanoes that extend from east to west across the North Atlantic Ocean. The chain was created by the movement of crustal plates across a relatively stationary “hot spot” plume of magma, deep in the Earth’s mantle. This same hotspot created New Hampshire’s White Mountains as it migrated eastward under the North American Tectonic Plate. The youngest and easternmost seamount (Great Meteor) formed approximately 80 million years ago and the oldest and westernmost seamount (Bear) formed approximately 100 million years ago. A detailed description of the geology of the New England Seamount Chain is [available here](#).

- ▶ During the [Northeast U.S. Canyons and Seamounts Expedition in 2013](#), a team of scientists and technicians both at sea and on shore conducted exploratory investigations on the diversity and distribution of deep-sea habitats and marine life along the Northeast U.S. Canyons and within the seamount chain, including a close look at Mytilus Seamount. This seamount was found to be a lush “biological island” in the deep sea.



Learn more about seamounts on the NOAA OER Theme pages.

<https://oceanexplorer.noaa.gov/edu/themes>



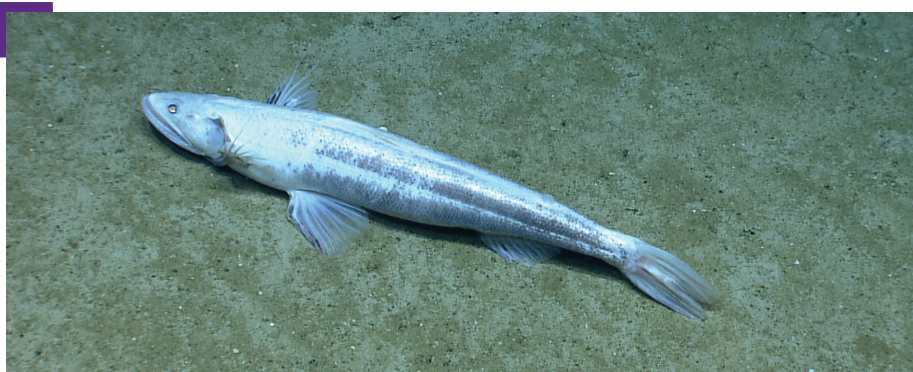
One Seamount, Two Dives

During this expedition, we explored Mytilus Seamount on two separate dives, one on the north side and one on the south side of the seamount. Mytilus is part of the New England Seamount Chain and is one of the deepest (over 3,000 meters at the base) and least-explored seamounts in the U.S. Exclusive Economic Zone.



Exclusive Economic Zones (EEZs)

are areas of the sea, generally extended 200 nautical miles from a country’s coastline. Within this zone, coastal countries retain special rights to exploration and the use of marine resources.



This deep-sea lizard fish (Bathysaurus) was observed on the south side of Mytilus Seamount. This fish sits on the bottom and grabs prey from the water column. Image courtesy of the NOAA Office of Ocean Exploration and Research, Northeast U.S. Canyons Expedition 2013.



Witch’s Hat Sponge

Sponges are abundant and diverse at Mytilus Seamount. Notice this large “witch’s hat” sponge provides structure for numerous glass sponges as well as some orange brittle stars.



Image courtesy of the NOAA Office of Ocean Exploration and Research, Northeast U.S. Canyons Expedition 2013.

Now that you know more about seamounts, let’s use the **OCEAN EXPLORATION DIGITAL ATLAS**, to explore Mytilus Seamount in the Northeast U.S.

Exploring a Northeast U.S. Seamount with Multibeam Sonar Tools

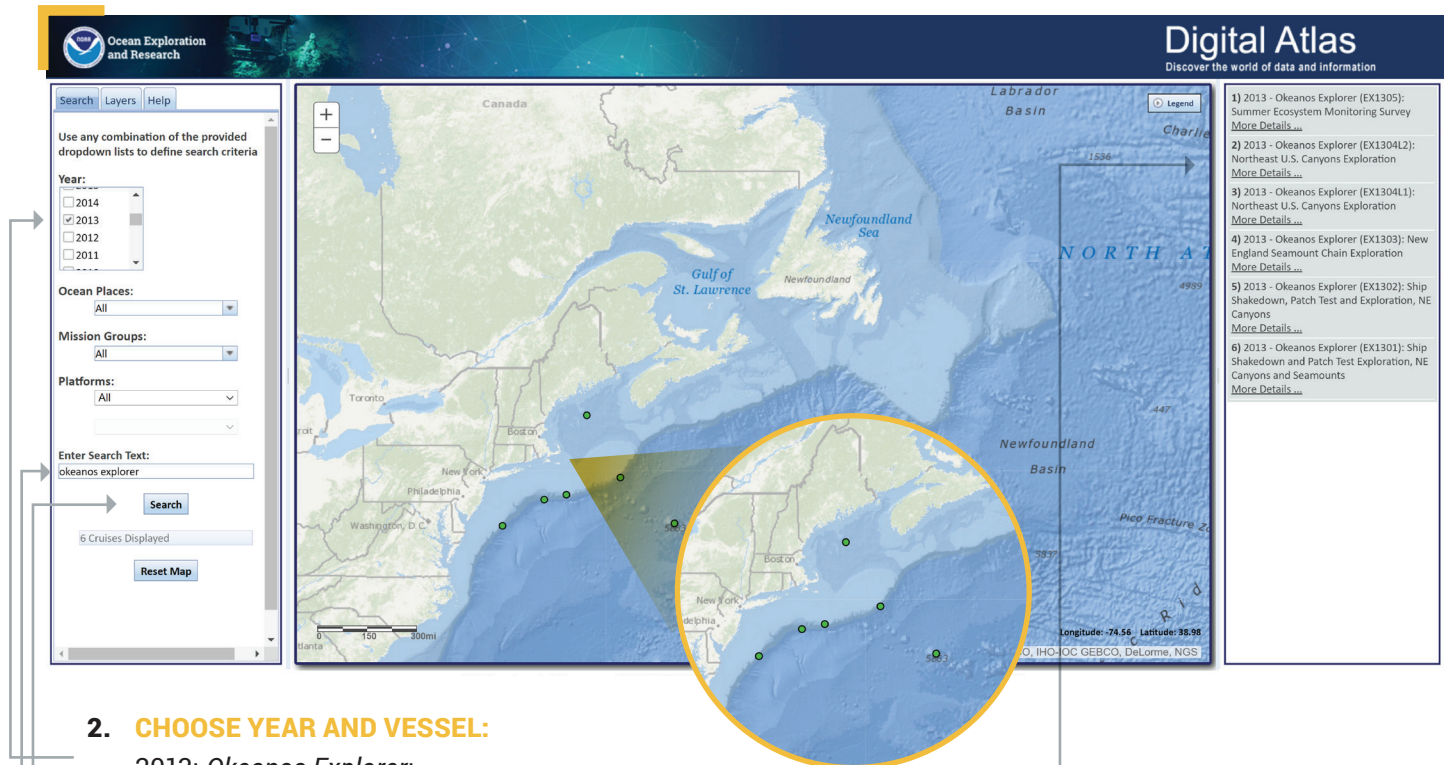
TOOL 1: Exploring Northeast U.S. Seamount with the Ocean Exploration Digital Atlas

The Ocean Exploration Digital Atlas is a map-based interactive online atlas tool provided by NOAA's National Centers for Environmental Information (NCEI). The atlas links to information about past expeditions of NOAA's Office of Ocean Exploration and Research missions that began in 2001. This atlas orients users to expedition locations and provides experiences exploring data and associated discoveries from specific expeditions.

Note: For a more detailed step-by-step tool guide of how to use the Ocean Exploration Digital Atlas, see the *Watching in 3D: Exploring with Multibeam Sonar activity package introduction*.

1. OPEN THE OCEAN EXPLORATION DIGITAL ATLAS:

- ▶ <https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm>




2. CHOOSE YEAR AND VESSEL:

2013; *Okeanos Explorer*;
Search. The dots that appear are all the 2013 *Okeanos Explorer* expeditions.

3. CHOOSE EXPEDITION:

2013 *Okeanos Explorer* Northeast U.S. Canyons Expedition (EX1304L2).

 **EX1304L2:** "EX" is used as an abbreviation for the NOAA Ship *Okeanos Explorer*, the last two digits of the year of the cruise (13) the number of the cruise (this was the fourth cruise for 2013), and the segment or leg (this was the second leg of cruise 04).

Exploring a Northeast U.S. Seamount with Multibeam Sonar Tools *cont.*

4. **PLOT ON MAP:** Click on the GIS Tools tab in the pop-up window, select the appropriate boxes (the first three for this mission) and click Plot on Map.

✓ GIS stands for Geographic Information Systems.

5. **LOOK CLOSER:** Click on the map and holding the left mouse button down, move the view slightly to the right and use the center mouse button to zoom in until the names of the dives appear.

6. **DIVE IN:** Look for the dives that explored Mytilus Seamount, EX1304L2 Dives 4 and 5. *What do you think the ship was doing here to make those green lines on the map? Can you think of anything in your life that makes similar patterns?* The green lines are the ship's track, or where it "mowed the lawn." Zoom in the see the flat top of Mytilus seamount.

Check longitude and latitude to make sure you are in the right place!

Longitude: -67.12 Latitude: 39.38
(provided in decimal format)

Now that you have found your dives and Mytilus Seamount, try the second tool, **FLEDERMAUS**, to explore this seamount even further. 🌐

✓ The color red is used to indicate the shallowest point, followed by orange, yellow, green, blue and purple, with purple being the deepest.

Exploring a Northeast U.S. Seamount with Multibeam Sonar Tools *cont.*

TOOL 2: Exploring a Northeast U.S. Seamount with Fledermaus

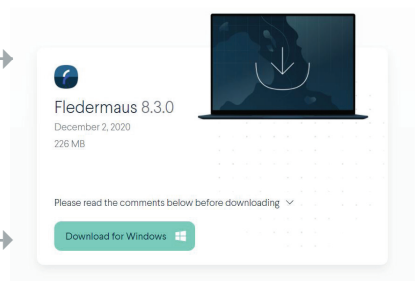
An important technique for studying multibeam images uses a three-dimensional data visualization system called Fledermaus. Fledermaus software allows the user to view and manipulate 3D models of seafloor features, providing insight into the geological structure of an area and helping to pinpoint ideal locations for further exploration.

✓ Fledermaus, pronounced "FLEE-der-mouse," is the German word for bat.

Note: For a more detailed step-by-step tool guide of how to use Fledermaus software, see the [Watching in 3D: Exploring with Multibeam Sonar activity package introduction](#).

1. DOWNLOAD THE (FREE) SOFTWARE (educators and/or students):

Download the Fledermaus Viewer software (8.2.2 or newer) from the dropdown menu at <https://www.qps.nl/downloads/fledermaus/>. Fill in the contact form, selecting the version appropriate to your operating system. You will receive a link via email to download the program.



2. CHOOSE SCENE: Download this interactive, 3D scene file of Mytilus Seamount and save it onto your hard drive:

https://www.ncei.noaa.gov/waf/OER-Media/ex1304l2/EX1304L2_MytilusSeamount.qsz.

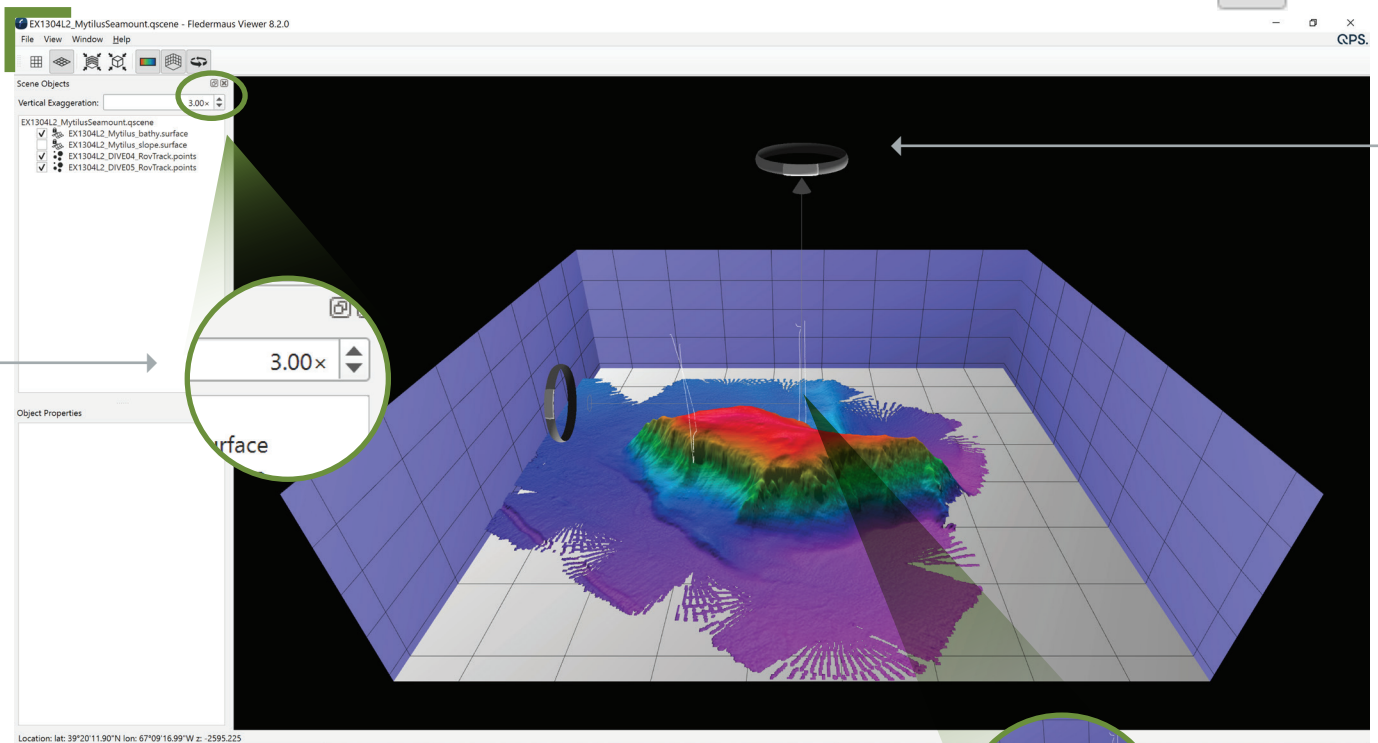
Then open the Viewer, and in the top left, select File and then Open Scene. Choose the scene you downloaded and this will open the 3D Mytilus scene file created from the multibeam sonar data collected as the ship traveled over and mapped the seafloor in this region.

✓ In the Fledermaus scenes, the ocean floor is shown as a three-dimensional image. Latitude and longitude are indicated in degrees, minutes and seconds. The x-axis represents longitude, the y-axis represents latitude, and the z-axis represents depth. When you move the cursor over the image, the window near the bottom of the screen shows the geo coordinates (x, y, and z) for the location beneath the cursor.

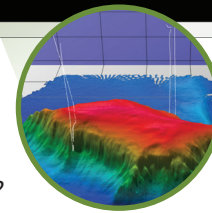
Exploring a Northeast U.S. Seamount with Multibeam Sonar Tools *cont.*

3. INTERACT: While the actual size is 1.00x, you'll notice the vertical exaggeration is set at 3.00x, which exaggerates the image in order to view the structure in more detail. Change the exaggeration to 6.00x and see what happens. The rings on the left and at the top of the image can be used to manipulate the view, too.

4. INTERACT FURTHER: In the Scene Objects box, different views of the region being explored can be selected. Checking the first box will provide a false color map of the region with purple being the deepest points and red being the shallowest points. Checking the second box will show the slope. Checking the third and fourth boxes will show the white track of the ROV for both dives (4 and 5) that explored Mylilus Seamount. Try zooming in to get a closer look! To return to the original scene file if needed, use the second icon in the top toolbar.



- 5. EXPLORE:** Looking at the image, what are you curious about?
- What is the length of the seamount from east to west?
 - What is the length of the seamount from north to south?
 - What is the deepest point of this seamount? What is the shallowest point?
 - What appears to be one of the steepest points on this seamount?



The white lines show the dive track of the ROV on the north (Dive 4) and south (Dive 5) sides of the seamount.

Based on your observations and where you know this seamount is located:

- What might be the reason this seamount has a flat top?
- What is the geology like at this seamount? Type of rock? Hardness of rock or sediment?
- What organisms might live here? Why? Do you think different organisms live at different depths on this seamount? Why or why not?
- Why do you think the scientists selected these dive locations?
- If you were the scientist leading this expedition and exploring this seamount for the first time, where would you choose to send the ROV?
- What considerations do you think need to be made when deciding what regions to select for further exploration?
- What differences might you expect between Dive 4 on the north side of the seamount and Dive 5 on the south side?

Now that you have explored the map of Mytilus Seamount, check out the **EXPEDITION WEB PAGES** on the NOAA Office of Ocean Exploration and Research website for more information.



Exploring a Northeast U.S. Seamount with Multibeam Sonar Tools *cont.*

TOOL 3: Expedition Web Pages


Each expedition has specific web pages on the [NOAA Office of Ocean Exploration and Research](https://oceanexplorer.noaa.gov) website.

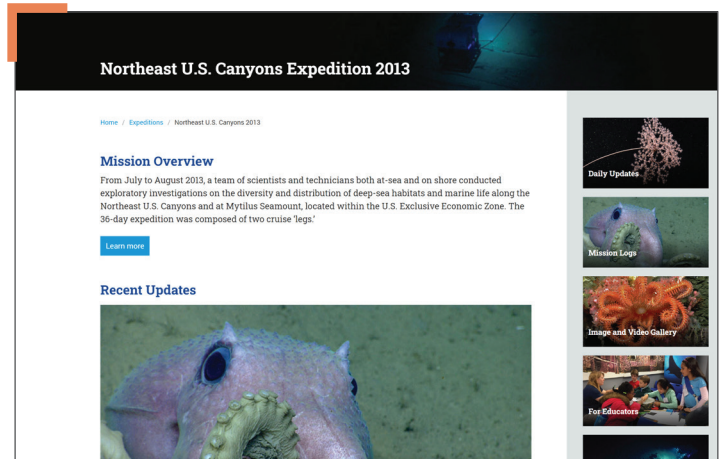
The 2013 Northeast U.S. Canyons Expedition web pages contain more information about Mytilus Seamount and other discoveries.

- ▶ <https://oceanexplorer.noaa.gov/oceanos/explorations/ex1304/welcome.html>

Here you can...

- meet the explorers
- watch a mission summary video
- read daily updates
- read mission logs
- read the mission plan
- view beautiful imagery, videos and more!

This web page can also be accessed by repeating steps 1-3 of the [Ocean Exploration Digital Atlas](#) and selecting the Summary tab (see page 3). 



1. BE THE EXPLORER

a. What was discovered?

- ▶ On the [Northeast U.S. Canyons Expedition web page](#), click [Daily Updates](#).
- READ the updates from Dive 4, Aug. 4, 2013 (north side of the seamount) and Dive 5, Aug. 5, 2013 (south side of the seamount).
- Now ask yourself:
 - *Why did scientists select this seamount for exploration?*
 - *What was the deepest point the ROV traveled during these two dives?*
 - *What is the primary type of rock present at this seamount? Why?*
 - *Why do you think there were more fish found on the south side of the seamount vs the north side?*
 - *Why do you think the science team made note of three types of black coral?*
 - *Can you answer some of the early questions?*
 - *If you were to take what was learned in this expedition and go back to investigate further, in what would you be interested?*

b. What else might you want to know? Perhaps...

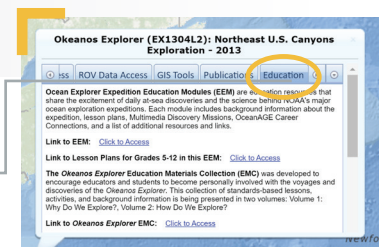
- *Why did the basalt rocks in Dive 4 have a manganese coating?*
- *How did pillow lava form in this location?*
- *Why do the hermit crabs found here have anemone houses?*
- *Why did different organisms inhabit different locations on the bamboo coral?*
- *What are some possible food chains and food webs in this region?*
- *Do different corals live at different depths?*
- *Why are there different organisms on the north vs the south side of this seamount?*



For Educators: Additional Resources and Extension

1. EDUCATION TAB

- ▶ In the [Ocean Exploration Digital Atlas](#) instructions on page 3 of this lesson, repeat steps 1-3, select the **Education** tab for a variety of supplemental educational resources.



2. SEAMOUNTS THEME PAGE

- ▶ The [Seamounts Theme page](#) provides additional essays, lessons, images, videos and more.

3. FURTHER MULTIMEDIA

- ▶ [Seamounts](#), Les Watling Ph.D., University of Hawai'i at Manoa; In this 45 minute video, Dr. Les Watling, marine scientist the University of Hawai'i at Manoa, provides an excellent description of the formation of seamounts, their geology and their associated ecological and biological diversity.

4. EXTENSION: Student Activity

- ▶ Have students [read the mission log \(Aug. 6, 2013\)](#) to see what the team learned!
In 2016, the President established the Northeast Canyons and Seamounts Marine National Monument.
- ▶ Have students [read the mission log \(Sept. 15, 2016\)](#) describing why.

Northeast U.S. Seamount Lesson URLs/Links

- Page 1:**
- ▶ Guyots: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1606/background/guyots-bio/welcome.html>
 - ▶ Fly-through videos: <https://oceanexplorer.noaa.gov/explorations/12fire/background/laubasin/laubasin.html>
 - ▶ Northeast U.S. Canyons and Seamounts Expedition in 2013: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html>
 - ▶ Listen (photo): <https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-MMBkgnd.pdf>
 - ▶ Test (photo): <https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-WCIntro.pdf>
 - ▶ Photograph (photo): <https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-URIntro.pdf>
 - ▶ Share (photo): <https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-TPbkgnd.pdf>
- Page 2:**
- ▶ Themes page: <https://oceanexplorer.noaa.gov/edu/themes>
 - ▶ Hotspots: <https://oceanexplorer.noaa.gov/facts/volcanic-hotspot.html>
 - ▶ New England Seamount Chain: <https://oceanexplorer.noaa.gov/explorations/03mountains/background/geology/geology.html>
 - ▶ Northeast U.S. Canyons and Seamounts Expedition in 2013: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html>
 - ▶ Deep-sea lizard fish (photo): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/logs/aug6/media/fish-hires.jpg>
 - ▶ Witch's hat sponge (photo): <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/logs/aug6/media/sponge-hires.jpg>
- Page 3:**
- ▶ Watching in 3D: Exploring with Multibeam Sonar activity package intro: <https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-Watching3Dinstructions.pdf>
 - ▶ Ocean Exploration Digital Atlas: <https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm>
- Page 5:**
- ▶ Watching in 3D: Exploring with Multibeam Sonar activity package intro: <https://oceanexplorer.noaa.gov/okeanos/edu/collection/media/hdwe-Watching3Dinstructions.pdf>
 - ▶ Fledermaus Viewer software: <https://www.qps.nl/downloads/fledermaus/>
 - ▶ Mytilus 3D scene file: https://www.ncei.noaa.gov/waf/OER-Media/ex1304l2/EX1304L2_MytilusSeamount.qsz
- Page 7:**
- ▶ NOAA Office of Ocean Exploration and Research website: <https://oceanexplorer.noaa.gov/>
 - ▶ 2013 Northeast U.S. Canyons Expedition Web Page: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/welcome.html>
 - ▶ 2013 Northeast U.S. Canyons Expedition Daily Updates: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/dailyupdates/dailyupdates.html>
- Page 8:**
- ▶ Ocean Exploration Digital Atlas: <https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm>
 - ▶ Seamounts Theme page: <https://oceanexplorer.noaa.gov/edu/themes/seamounts/welcome.html>
 - ▶ Seamounts (video): <https://vimeo.com/88841596>
 - ▶ Mission Log Aug. 6, 2013: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1304/logs/aug6/aug6.html>
 - ▶ Mission Log Sept. 15, 2016: <https://oceanexplorer.noaa.gov/okeanos/explorations/ex1905/background/ncsmnm/welcome.html>

Information and Feedback



Ocean Exploration
and Research

We value your feedback on this activity package, including how you use it in your formal/informal education settings. Please send your comments to: oceaneducation@noaa.gov. If reproducing this lesson, please cite NOAA as the source, and provide the following URL: <https://oceanexplorer.noaa.gov>.