Education Content

NOAA Ocean Exploration engages educators, students and the general public to enhance America's environmental literacy through the excitement of ocean discovery. Educational resources are designed to explore deep-sea phenomena to support formal and informal classroom instruction and inspire students to better understand our ocean planet. Since ocean exploration touches on various disciplines—biology, chemistry, physics, geography, and even history, our education content allow students to explore these subjects in an integrated way, helping them see the connections between different fields of study. This holistic approach mirrors how scientists work in real-life situations, making learning more cohesive. The education team packages various types of educational materials, including lessons, fact sheets, instructional and informational videos, into topical packages to provide educators with resources that are easy to understand, easy to access, and easy to implement.

Lessons & Student Investigations

For over two decades, NOAA Ocean Exploration lessons have been developed by educators and scientists to demonstrate key ocean science and exploration. Lesson development has regularly evolved with science education trends, always striving to support current classroom science standards and the Ocean Literacy Essential Principles and Fundamental Concepts. Most recently, the education team worked with the National Science Teaching Association to develop a series of investigative lessons that guide students through the sensemaking process to help them *make sense of deep-sea phenomena* in direct support of the Next Generation Science Standards for grades 6-8 and 9-12.

A few examples featuring data and discoveries made during NOAA Ocean Exploration funded expeditions:

Feeding the Million Mounds of Deep-Sea Coral

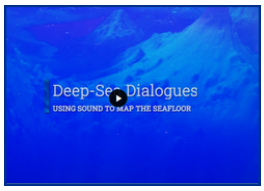
Seamounts and Biological Productivity

Fact Sheets

Ocean Exploration topical fact sheets are written and designed to support middle and high school classroom instruction associated with ocean exploration themes covered by NOAA Ocean Exploration lessons. Three to four fact sheets have been developed for each topic.

Deep-Sea Dialogues

The Deep-Sea Dialogues are ~10 minute interviews with experts. These visually engaging education products provide viewers with a foundational introduction to ocean exploration subjects through the eyes of authentic and unique voices working within the field.



The following pages feature educational content that has been developed since the last education program review. Since then, packages of educational content including lessons/student investigations, fact sheets, deep-sea dialogues videos, and more have been developed for seven themes including bioluminescence, cold seeps, deep-sea corals, hydrothermal vents, seafloor mapping, seamounts, and underwater robots. Additional fact sheets have also been developed on why do we explore, deep-sea sampling, maritime heritage.

https://oceanexplorer.noaa.gov/edu/welcome.html

Bioluminescence

Bioluminescence, or the ability of an organism to create light, is one of nature's most amazing phenomena, seemingly drawn more from science fiction than science and natural history. It has been estimated that 90% of the animals living in the pelagic zone (water column) are bioluminescent. However, information on bioluminescence in the deep-sea benthos (organisms that live on the ocean bottom) is sparse.

Scan the QR code above and explore a variety of educational resources to learn more about bioluminescence and teach about this incredible phenomenon in your classroom.

BACKGROUND INFORMATION

Fact Sheets

Print-friendly, informational sheets. Also available in Spanish.

Bioluminescence
https://oceanexplorer.noaa.gov/edu/materials/bioluminescence-fact-sheet.pdf

Three Mysterious Light Effects
https://oceanexplorer.noaa.gov/edu/materials/3-light-effects-fact-sheet.pdf

Light and Color in the Deep Sea
https://oceanexplorer.noaa.gov/edu/materials/light-and-color-fact-sheet.pdf

Deep-Sea Dialogues

This 8-minute video interview features PhD candidate Rene Martin, who studies the evolution of deep-sea fishes and the "why" and "how" behind bioluminescence.

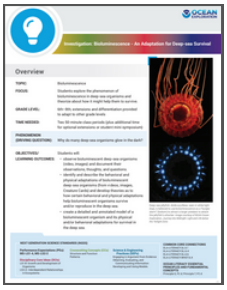
https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#bioluminescence

LESSONS

The Science of Light and Color in the Deep Ocean
Grades 6-8 | Physical Science, Electromagnetic Waves

Students explore the phenomenon of light and color in the ocean through sensemaking. This process includes investigating how light interacts with different materials, making connections between the observed phenomenon and what happens to light as it passes through the ocean.

https://oceanexplorer.noaa.gov/edu/themes/bioluminescence/lessons/light-and-color.html



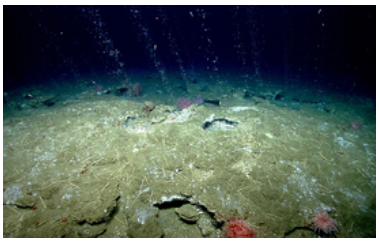
Bioluminescence - An Adaptation for Deep Sea Survival
Grades 6-8 | Life Science, Adaptations

Students explore the phenomenon of bioluminescence in deep-sea organisms and theorize about how it might help them to survive.

https://oceanexplorer.noaa.gov/edu/themes/bioluminescence/lessons/adaptation-for-survival.html

https://oceanexplorer.noaa.gov/edu/themes/bioluminescence/welcome.html

Cold Seeps



Cold seeps are locations where hydrocarbon-rich fluid seeps up from below the seafloor, often as methane or hydrogen sulfide. Cold seeps have been found to support significant chemosynthetic communities, which produce food using chemical energy.

Scan the QR code above and explore a variety of educational resources to learn more about cold seeps and teach about this incredible ecosystem in your classroom.

BACKGROUND INFORMATION

Fact Sheets

Print-friendly, informational sheets.
Also available in Spanish.

Cold Seeps
https://oceanexplorer.noaa.gov/edu/materials/what-are-cold-seeps-fact-sheet.pdf

Cold Seep Communities
https://oceanexplorer.noaa.gov/edu/materials/cold-seep-communities-fact-sheet.pdf

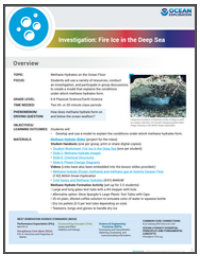
Chemosynthesis
https://oceanexplorer.noaa.gov/edu/materials/chemosynthesis-fact-sheet.pdf

Deep-Sea Dialogues

This 11-minute video interview features PhD candidate Melissa Betters, who studies the evolutionary origins of chemosynthetic organisms found at cold seeps.

https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#cold-seeps

LESSONS



Fire Ice in the Deep Sea
Grades 6-8 | Physical Science/Properties of Matter

Students analyze chemical structures and make observations in order to develop and use a model to explain the phenomenon: How does methane hydrate form on and below the seafloor?

https://oceanexplorer.noaa.gov/edu/themes/cold-seeps/lessons/fire-ice-in-deep-sea.html

Methane Ice Worms
Grades 9-12 | Life Science, Chemosynthesis

Students evaluate evidence and reasoning in order to construct an argument that supports a claim about the phenomenon: How do methane ice worms obtain organic compounds and energy while living on methane hydrate?

https://oceanexplorer.noaa.gov/edu/themes/cold-seeps/lessons/methane-ice-worms.html

https://oceanexplorer.noaa.gov/edu/themes/cold-seeps/welcome.html

Deep-Sea Corals

Not all corals are found on island coasts in shallow seas. In fact, over half of all known coral species are found in deep, dark waters where temperatures range from 4-12°C (39-54°F). For this reason, we call these corals the "cold-water" or "deep-sea" corals. They are found all over the world.

Scan the QR code above and explore a variety of educational resources to learn more about deep-sea corals and teach about them in your classroom.

BACKGROUND INFORMATION

Fact Sheets

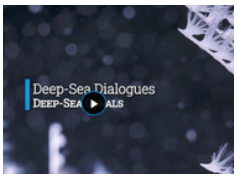
Print-friendly, informational sheets.
Also available in Spanish.

Deep-Sea Corals: What Are They?
https://oceanexplorer.noaa.gov/edu/materials/deep-sea-corals-fact-sheet.pdf

Deep-Sea Corals: Rainforests of the Deep
https://oceanexplorer.noaa.gov/edu/materials/rainforests-of-the-deep-fact-sheet.pdf

Deep-Sea Corals and Sponges: Foundation Species
https://oceanexplorer.noaa.gov/edu/materials/DSC-foundation-species-fact-sheet.pdf

Deep-Sea Dialogues



This 13-minute video interview features Dr. Randi Rotjan, and shares her excitement in studying the ecology and physiology of deep-sea corals.

https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#corals

LESSONS

Feeding the Million Mounds of Deep-Sea Coral
Grades 6-8 | Life Science, Ecosystem Dynamics

Students analyze and interpret data from the Million Mounds coral region of the southeastern U.S. including currents and plankton movement to explain the phenomenon: How do the deep-sea corals of the Million Mounds region get the food they need to grow and reproduce?
https://oceanexplorer.noaa.gov/edu/themes/deep-sea-corals/lessons/feeding-million-mounds.html

Laying the Foundation for Deep-Sea Coral Gardens
Grades 9-12 | Life Science, Ecosystem Dynamics

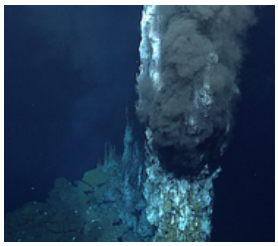
Students use data and images from deep-sea coral gardens to construct an explanation for the deep-sea phenomenon: How does the presence of *Lophelia pertusa* affect other organisms in a deep-sea coral ecosystem?
https://oceanexplorer.noaa.gov/edu/themes/deep-sea-corals/lessons/foundation-for-deep-corals.html

Deep Coral Communities Curriculum
Grades 9-12 | Life Science, Ecosystem Dynamics

Students investigate the unique biology of deep-sea corals and learn to identify corals and other animals found within these communities; use real video transects taken with remotely operated vehicles to gain practice recording species observations and analyzing results.
https://sanctuaries.noaa.gov/education/teachers/deep-coral-communities/

https://oceanexplorer.noaa.gov/edu/themes/deep-sea-corals/welcome.html

Hydrothermal Vents



Hydrothermal vents are the result of sea water percolating down through fissures in the ocean crust near spreading centers or subduction zones. The cold seawater is heated by hot magma, and reemerges to form the vents. Despite being in areas with no light for sunlight-driven food production, extinct, and even mildly active, vent sites often support diverse communities of animals that have adapted to produce food using chemical energy, via a process known as chemosynthesis.

Scan the QR code above and explore a variety of educational resources to learn more about hydrothermal vents and teach about them in your classroom.

BACKGROUND INFORMATION

Fact Sheets

Print-friendly, informational sheets.
Also available in Spanish.

Hydrothermal Vents
https://oceanexplorer.noaa.gov/edu/materials/hydrothermal-vents-fact-sheet.pdf

Chemosynthesis
https://oceanexplorer.noaa.gov/edu/materials/chemosynthesis-fact-sheet.pdf

Deep-Sea Dialogues

This 9-minute video features vent scientists, Ashton Flinders and Diva Amon, share the fascinating geology and biology of hydrothermal vents and why studying these remote habitats is so important.

https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#hydrothermal-vents

LESSONS

How Black Smoker Chimneys Form
Grades 6-8 | Geology/Chemistry

Students explore how a solid forms from the mixing of two liquids and use the science ideas they develop to help explain the phenomenon of how chimneys form at hydrothermal vents.

https://oceanexplorer.noaa.gov/edu/themes/vents-and-volcanoes/lessons/black-smoker.html

Life on a Hydrothermal Vent
Grades 9-12 | Life Science/Chemosynthesis

Students ask questions and identify patterns to investigate the phenomenon: How can ecosystems survive without sunlight?

https://oceanexplorer.noaa.gov/edu/themes/vents-and-volcanoes/lessons/life-hydrothermal-vent.html

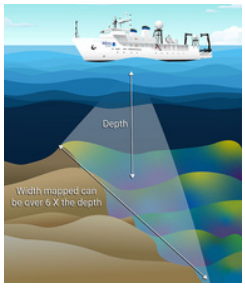
Using Chemistry to Find Vents
Grades 6-8 | Chemistry

Students explore the process of engineering a scientific remotely operated vehicle (ROV) from concept to launch using Schmidt Ocean Institute's ROV Subastian as an example.

https://oceanexplorer.noaa.gov/edu/themes/vents-and-volcanoes/lessons/chemistry-vents.html

https://oceanexplorer.noaa.gov/edu/themes/vents-and-volcanoes/welcome.html

Seafloor Mapping



A key part of exploration is creating maps to plan efficient and safe expeditions. Multibeam sonars collect high-resolution data using multiple, simultaneous sonar beams (sound waves) at once in a fan-like pattern or "swath." Multibeam sonar data allow teams to spot previously unseen features such as seamounts, ancient coral reefs, shipwrecks, and more.

Scan the QR code above and explore a variety of educational resources to learn more about seafloor mapping and teach about this important exploration tool in your classroom.

BACKGROUND INFORMATION

Fact Sheets

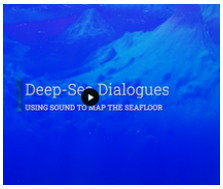
Print-friendly, informational sheets.

Bathymetric Maps
https://oceanexplorer.noaa.gov/edu/materials/bathymetric-mapping-fact-sheet.pdf

Sonar: Seeing with Sound
https://oceanexplorer.noaa.gov/edu/materials/sonar-fact-sheet.pdf

Multibeam Sonar
https://oceanexplorer.noaa.gov/edu/materials/multibeam-sonar-fact-sheet.pdf

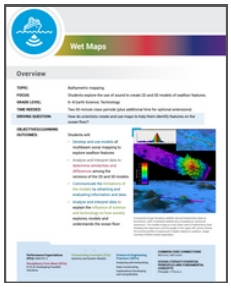
Deep-Sea Dialogues



Detailed seafloor maps are critical tools for exploration. This 9-minute video features Mapping Operations Manager Derek Sowers, sharing the science behind deep-ocean mapping.

https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#sound-mapping

LESSONS



Wet Maps
Grades 6-8 | Earth Science, Technology

Students analyze and interpret data to explain how multibeam sonar is used to identify patterns of ocean floor structures, construct three-dimensional maps, and understand how multibeam sonar technology extends the measurement and exploration capacity of modern ocean exploration.

https://oceanexplorer.noaa.gov/edu/themes/seafloor-mapping/lessons/wet-maps.html

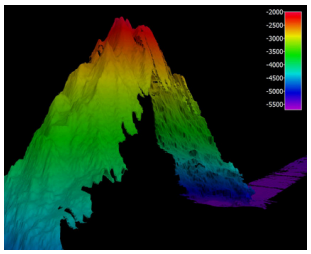
Watching in 3D: Exploring Multibeam Sonar
Grades 9-12 | Technology, Physical Sciences, Life Sciences

Students explore how multibeam sonar is used to study the shape and composition of the ocean floor and, through multiple Case Studies and video samples, learn to analyze and interpret maps of specific seafloor features using authentic multibeam sonar data.

https://oceanexplorer.noaa.gov/edu/themes/seafloor-mapping/lessons/3d-multibeam-sonar.html

https://oceanexplorer.noaa.gov/edu/themes/seafloor-mapping/welcome.html

Seamounts



Seamounts are often remnants of extinct volcanoes and come in a variety of shapes and sizes. Seamounts can be found in every world ocean basin and scientists estimate that the number of seamounts around the globe ranges from 14,700 to more than 33,000 total.

Scan the QR code above and explore a variety of educational resources to learn more about seamounts and teach about them in your classroom.

BACKGROUND INFORMATION

Fact Sheets

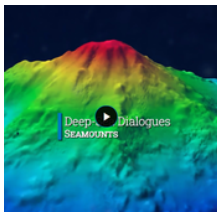
Print-friendly, informational sheets.
Also available in Spanish.

What is a Seamount
https://oceanexplorer.noaa.gov/edu/materials/what-is-a-seamount-fact-sheet.pdf

How Do Seamounts Form?
https://oceanexplorer.noaa.gov/edu/materials/how-seamounts-form-fact-sheet.pdf

Seamounts: Oases of Life
https://oceanexplorer.noaa.gov/edu/materials/seamounts-oases-of-life-fact-sheet.pdf

Deep-Sea Dialogues



This 8-minute video features geologist Thomas Morrow and biologist Megan Putts introducing the wonders of seamounts, how they form, and the rich and diverse habitats they create.

https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#seamounts

LESSONS

Formation of Seamounts and Island Chains
Grades 6-8 | Earth Science, Plate Tectonics

Students analyze data and images to investigate how the distribution of seamounts and island chains provides evidence of past and current tectonic processes and develop an explanation to the phenomenon: How do seamounts and island chains form in the middle of the ocean?

https://oceanexplorer.noaa.gov/edu/themes/seamounts/lessons/seamounts-island-chains.html

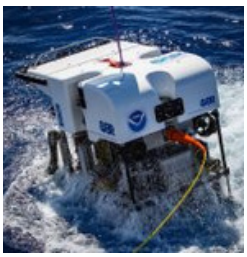
Seamounts and Biological Productivity
Grades 9-12 | Earth Science, Biogeology

Students analyze data and use models to make sense of the role seamounts have in increasing productivity in overlying and surrounding ocean waters.

https://oceanexplorer.noaa.gov/edu/themes/seamounts/lessons/seamounts-biological-productivity.html

https://oceanexplorer.noaa.gov/edu/themes/seamounts/welcome.html

Underwater Robots



Underwater robots, such as remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), are essential tools for ocean exploration. They can explore areas of the ocean that are too dangerous or too difficult for humans to go. Underwater robots come in a variety of shapes and sizes and can be outfitted with numerous sensors and tools to collect extensive amounts of data from deep-sea environments.

Scan the QR code above and explore a variety of educational resources to learn more about underwater robots and teach about them in your classroom.

BACKGROUND INFORMATION

Fact Sheets

Print-friendly, informational sheets.
Also available in Spanish.

What is an ROV?
https://oceanexplorer.noaa.gov/edu/materials/rov-fact-sheet.pdf

What is an AUV?
https://oceanexplorer.noaa.gov/edu/materials/auv-fact-sheet.pdf

Deep-Sea Dialogues

This 11-minute video features ocean engineers Jessica Sandoval and Brennan Phillips who work with and design innovative technologies to explore our ocean.

https://oceanexplorer.noaa.gov/edu/multimedia-resources/dsd/dsd.html#underwater-robots

LESSONS

Simple Machines: Robot Building Blocks
Grades 6-8 | Engineering Design/Technology

Students practice the engineering design process to develop a working manipulator arm for a Remotely Operated Vehicle (ROV). Through this process students combine simple machines to develop complex systems, like manipulator arms, and develop a hydraulic actuator that converts energy into motion.
https://oceanexplorer.noaa.gov/edu/themes/underwater-robots/lessons/simple-machines.html

Which Robot When
Grades 6-8 | Physical Science/Engineering

Students learn about the variety of underwater robots that are used for ocean exploration and the technical capabilities that differentiate them from one another. Students analyze several mission scenarios and apply their knowledge of underwater robots to figure out which robot is best suited for the task.
https://oceanexplorer.noaa.gov/edu/themes/underwater-robots/lessons/which-robot-when.html

Designing a Scientific ROV
Grades 9-12 | Engineering Design/Technology

Students explore the process of engineering a scientific remotely operated vehicle (ROV) from concept to launch using Schmidt Ocean Institute's ROV Subastian as an example.
https://oceanexplorer.noaa.gov/edu/themes/underwater-robots/lessons/design-scientific-rov.html

https://oceanexplorer.noaa.gov/edu/themes/underwater-robots/welcome.html

Maximizing Accesibility

508 Compliance

Section 508 is an amendment to the US Workforce Rehabilitation Act of 1973--a federal law that mandates all federal agencies make their electronic and information technology (such as publications, presentations, software and websites) accessible to people with disabilities.

All education products that are posted to oceanexplorer.noaa.gov meet current 508 requirements to ensure they are accessible to everyone, including people with disabilities that utilize assistive technologies such as screen or text readers to read a document.

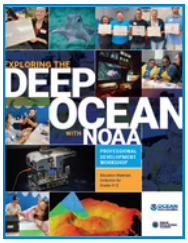
Translations

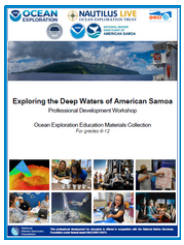
Following the model of education for all - NOAA Ocean Exploration offers a number of education materials in languages other than English. Some of this work has been led by scientists and partners on international expeditions. Together they have helped translate topical fact sheets that are relevant to their research into the regional language. Most recently, this included translating a set of fact sheets into Portuguese to support expeditions to the Mid-Atlantic Ridge.

Additionally, the education program aims to translate all of the topical fact sheets to Spanish by the end of the calendar year. To date 15 fact sheets have been translated and are available on the web. Another 12 are in the process of being translated. All translated fact sheets are available here: https://oceanexplorer.noaa.gov/edu/materials/fact-sheets.html

The team is also working on translating all lessons that are part of the Exploring the Deep Ocean with NOAA professional development workshop for educators grades 6-12 with the goal of offering the workshop fully in Spanish in the spring of 2025.

Providing Printed Materials for Teacher Workshops





NOAA Ocean Exploration also packages print-friendly educational content including lessons/investigations, fact sheets, and background information about deep-ocean subjects into collections of materials for each of the educator professional development events. While the team was working towards going 100% digital with all of their educational products, workshop participants between 2020 - 2023 specifically noted that they missed the printed materials that were provided at pre-COVID workshops. These materials also have the ability to be versioned to support the specific needs of novel communities and workshops.

Partnering With Professionals

Writing and Designing Products With Industry Professionals

None of this work would be possible without the support for development, design, and translation from industry professionals! The team works with active classroom educators and has even partnered with the National Science Teaching Association to ensure all lessons and investigations are designed using modern classroom instructional techniques and meet the everyday needs and constraints of classroom educators. Fact sheets have all been co-developed with scientists and partners in the ocean exploration industry. Most recently these have been supported by the Ocean Exploration Cooperative Institute. The team partnered with and continues to use a professional graphic designer to produce print-ready products that are visually engaging and easy to use by all. Spanish translations are all initially conducted via a translation service that uses an AI-based system that creates a unique project memory for vocabulary in our work. All translated products are then sent to a practicing, bilingual educator to review accuracy of scientific vocabulary translations (so they are not literal word for word translations) and that materials remain at a middle school reading level.