



**Ocean Exploration
and Research**

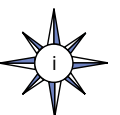
**The NOAA Ship *Okeanos Explorer*
Education Materials Collection
For Grades 5 – 12**

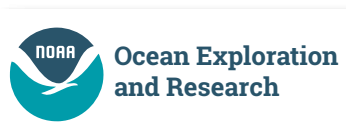
Volume 1:

Why Do We Explore?



**National Oceanic and Atmospheric Administration
Office of Ocean Exploration and Research**





November 2010
2nd Edition June 2012
3rd Edition August 2015

Project Manager: Paula Keener, Director, Education Programs
NOAA Office of Ocean Exploration and Research

Lesson Plan Development: Mel Goodwin, PhD, Marine Biologist and Science Writer, Charleston, SC

Design/Layout: Sandy Goodwin, Coastal Images Graphic Design, Mt Pleasant, SC

Reviewer: Susan Haynes, Education Program Manager, NOAA Office of Ocean Exploration and Research,
Contractor: Collabralink Technologies, Inc.

Cover photos courtesy National Oceanic and Atmospheric Administration (NOAA).

This collection of materials was produced for NOAA.

If reproducing materials from this collection, please cite NOAA as the source,
and provide the following URL:

<http://oceanexplorer.noaa.gov>

For more information, please contact:
Paula Keener, Director, Education Programs
NOAA Office of Ocean Exploration and Research
1315 East-West Highway
Silver Spring, MD 20910
Paula.Keener@noaa.gov



The NOAA Ship *Okeanos Explorer* Education Materials Collection

NOAA Ship *Okeanos Explorer*: America's Ship for Ocean Exploration.
Image credit: NOAA. For more information, see the following
Web site:
<http://oceanexplorer.noaa.gov/okeanos/welcome.html>

Table of Contents

Introduction vi

**Using the
Okeanos Explorer Education Materials Collection vii**

**Section 1:
Background Information for
Volume 1: Why Do We Explore?**

To Boldly Go 9

Guides student investigations into the reasons for ocean exploration.

Hands-on activity: Construct learning shapes to reinforce concepts resulting from student investigations and to summarize modern reasons for ocean exploration.

Diving Deeper 21

**Section 2:
Key Topic – Ocean Exploration**

Journey to the Unknown (Grades 5-6) 43

Students will experience the excitement of discovery and problem-solving to learn what organisms could live in extreme environments in the deep ocean, and will understand the importance of ocean exploration.

Hands-on activity: Posterize images and construct an ultraviolet LED poster illuminator.

Come on Down! (Grades 7-8) 55

Students will research the development and use of research vessels/vehicles used for deep-ocean exploration; calculate the density of objects by determining the mass and volume; and construct a device that exhibits neutral buoyancy.

Hands-on activity: Construct an electronic force sensor.

Calling All Explorers (Grades 9-12) 69

Students will learn what it means to be an explorer, both modern and historic; recognize that not all exploration occurs on land; understand the importance of curiosity, exploration, and the ability to document what one studies; gain insight into the vastness of unexplored places in the deep sea; and gain appreciation of science mentors and role models.

Hands-on activity: Your Own Expedition of Discovery (Geocaching)



Section 3:

Key Topic – Climate Change

The Methane Circus (Grades 5-6) 79

Students will describe the overall events that occurred during the “Cambrian explosion,” explain how methane hydrates may contribute to global warming, and describe the reasoning behind hypotheses that link methane hydrates with the Cambrian explosion.

Hands-on activity: Create model fossils of organisms that appeared during the Cambrian explosion.

Where Have All the Glaciers Gone? (Grades 7-8) 91

Students will describe how climate change is affecting sea ice, vegetation, and glaciers in the Arctic region, explain how changes in the Arctic climate can produce global impacts, and provide three examples of such impacts. Students will explain how a given impact resulting from climate change may be considered ‘positive’ as well as ‘negative’, and will be able to provide examples of each.

Hands-on activity: Make a photocube showing changes in glaciers.

History’s Thermometers (Grades 9-12) 107

Students will explain the concept of paleoclimatological proxies, learn how oxygen isotope ratios are related to water temperature, and interpret data on oxygen isotope ratios to make inferences about climate and climate change in the geologic past.

Hands-on activity: Scientific posters

Section 4:

Key Topic – Energy

Animals of the Fire Ice (Grades 5-6) 117

Students will define and describe methane hydrate ice worms and hydrate shrimp, infer how methane hydrate ice worms and hydrate shrimp obtain their food, and infer how methane hydrate ice worms and hydrate shrimp may interact with other species in their biological communities.

Hands-on activity: Model a methane hydrate molecule.

Oceans of Energy (Grades 7-8) 131

Students will describe forms of energy, explain how each form is used by humans, and discuss at least three ways that energy can be obtained from the ocean.

Hands-on activity: Build a simple turbine.

What’s the Big Deal? (Grades 9-12) 147

Students will define methane hydrates and describe where these substances are typically found and how they are believed to be formed. Students will also describe at least three ways in which methane hydrates could have a direct impact on their own lives, and describe how additional knowledge of methane hydrates could provide human benefits.

Hands-on activity: Construct a methane hydrate molecule.





Section 5:

Key Topic – Human Health

Microfriends (Grades 5-6)..... 161

Students will describe at least three ways in which microorganisms benefit people, describe aseptic procedures, and culture a bacterial sample on a nutrient medium.

Hands-on activity: Bacteria culture

What Killed the Seeds? (Grades 7-8)..... 171

Students will explain and carry out a simple process for studying the biological effects of chemicals and will be able to infer why organisms such as sessile marine invertebrates appear to be promising sources of new drugs.

Hands-on activity: Bioassay

Watch the Screen (Grades 9-12)..... 179

Students will be able to explain and carry out a simple process for screening natural products for biological activity, and will be able to infer why organisms such as sessile marine invertebrates appear to be promising sources of new drugs.

Hands-on activity: Screening plant products for antibacterial properties

Section 6:

Key Topic – Ocean Health

Build Your Own Ocean Ecosystem (Grades 5-6) 189

Students will identify key functions that are present in healthy ocean ecosystems, and discuss how these functions are met by living and non-living components in a model aquatic ecosystem.

Hands-on activity: Build an ecosystem in a bottle.

Stressed Out! (Grades 7-8)..... 197

Students will identify stresses that threaten the health of ocean ecosystems, explain natural and human-caused processes that contribute to these stresses, and discuss actions that may be taken to reduce them.

Hands-on activity: Experiments with a tabletop biosphere

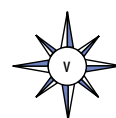
Off Base (Grades 9-12) 207

Students will define pH and buffer, explain in general terms the carbonate buffer system of seawater, explain Le Chatelier's Principle, predict how the carbonate buffer system of seawater will respond to a change in concentration of hydrogen ions, identify how an increase in atmospheric carbon dioxide might affect the pH of the ocean, and discuss how this alteration in pH might affect biological organisms.

Hands-on activity: Experiment with pH buffers

Resources217

Ocean Literacy Correlation Matrix225



Introduction

“The people who were putting up millions of dollars were asking my father, ‘So, Captain, what do you expect to find?’ and his answer to those people who were about to make major commitments was, ‘If I knew, I wouldn’t go.’”

Jean-Michel Cousteau, 2005

The wonders of the deep ocean and the mysteries of the universe. Inner Space and Outer Space. Both have historically and inextricably been linked with “exploration” and “discovery” since the beginning of humankind. For ages, people have gazed at planetary objects seemingly floating in the night sky and as early as 2,000 B.C., the Egyptians were exploring the seas. Astronomers and sailors—explorers driven by the human spirit of discovery and a fundamental need to know. What drives this quest for knowledge about the natural world, this fundamental need to know and understand what makes the planets move and the ocean change color?

Even as infants, humans are already exploring their world. In their book, *The Scientist in the Crib*, Gopnik *et al.* (2001) write “The tiny fingers and mouth are exploration devices that probe the alien world around them with more precision than any Mars rover. We are born with the ability to discover the secrets of the universe and of our own minds, and with the drive to explore and experiment until we do. Science isn’t just the specialized province of a chilly elite; instead, it’s continuous with the kind of learning every one of us does when we’re very small.” Can we capture and direct this innate need to know in novel ways to enhance science literacy?

The President’s Panel on Ocean Exploration fully recognized the importance of the connections among our fundamental need to know, ocean exploration, and science literacy when it called for “reaching out in new ways to learners of all ages with respect to ocean issues” (*Discovering Earth’s Final Frontier: A U.S. Strategy for Ocean Exploration*, 2000). The President’s Panel also had a vision of “a flagship for the Ocean Exploration Program . . . that would facilitate multidisciplinary data management and educational outreach by centralizing much of the data collection and outreach technologies on a dedicated platform through telepresence.”

In 2008, the National Oceanic and Atmospheric Administration (NOAA) commissioned the NOAA Ship *Okeanos Explorer* as the first Federally-dedicated ship of exploration intended to carry out systematic global ocean exploration linked in real



time through satellite and internet telepresence technology to scientists, educators, media and the general public. This ship offers an unprecedented opportunity to bring learners of all ages onboard for voyages to poorly-known or unexplored areas of the global ocean. Through the use of innovative technologies, they participate in explorations and breakthrough discoveries that lead to increased scientific understanding and enhanced literacy about our ocean world.

The **Why Do We Explore? Education Materials Collection** is part of a two-volume set that introduces the NOAA Ship *Okeanos Explorer* into formal and informal learning environments. The concept for this Collection was developed by participants during a two-day NOAA Ship *Okeanos Explorer* Education Forum held at the NOAA Pacific Marine Environmental Laboratory Western Regional Center Campus in Seattle immediately following the commissioning of the ship. The Forum focused on how best to reach students, teachers, and other audiences in novel ways with the excitement of ocean exploration given the unique combination of assets and capabilities brought to the NOAA Ocean Exploration and Research Program by the *Okeanos Explorer*.

The NOAA Ship *Okeanos Explorer* presents a unique national ocean-based venue through which to continue to implement the President’s Panel recommendation of “reaching out in new ways to learners.” It is our hope that these education materials, along with the ship and her telepresence capabilities bringing ocean exploration and new discoveries to scientists educators and their students, will have a profound effect on ocean literacy around the world as we, through our fundamental need to know, strive to understand our intrinsic connections with the ocean more fully and why it is called the “lifeblood of Earth.”

*Paula Keener, Director, Education Programs
NOAA Office of Ocean Exploration and Research*





Using the *Okeanos Explorer* Education Materials Collection

An essential component of NOAA's Ocean Exploration and Research Program mission is to enhance understanding of science, technology, engineering, and mathematics used in exploring the ocean; and build interest in careers that support ocean-related work. To help fulfill this mission, the ***Okeanos Explorer* Education Materials Collection** was developed to encourage educators and students to become personally involved with the voyages and discoveries of the *Okeanos Explorer*—America's first Federal ship dedicated to ocean exploration. The **Education Materials Collection** is presented in three volumes: *Volume 1: Why Do We Explore?* (reasons for ocean exploration), *Volume 2: How Do We Explore?* (exploration methods), and *Volume 3: What Do We Expect to Find?* (recent discoveries that give us clues about what we may find in Earth's largely unknown ocean). In the future, additional guides will be added to the **Education Materials Collection** to support the involvement of citizen scientists.

Education materials for *Volume 1 - Why Do We Explore?* begin with a lesson titled *To Boldly Go...* to guide students through some of the reasons for ocean exploration; and to provide educators background information on key topics of Ocean Exploration, Climate Change, Energy, Human Health, and Ocean Health. The Diving Deeper section, starting on page 21, offers additional information on some aspects and the subsequent 15 lessons guide further investigations into these topics. Some of these lessons have been adapted from lessons previously developed for various NOAA Ocean Explorer expeditions, while others have been created specifically for the *Okeanos Explorer* education initiative. Whenever possible, hands-on activities are included that involve manipulations other than

paper-and-pencil exercises or Web-based research. The reason for doing this is that field science, and exploration in particular, depend heavily upon technology and problem-solving skills needed to create, use, and advance new technology.

Lesson plans developed for Volume 1 are correlated with Ocean Literacy Essential Principles and Fundamental Concepts as indicated in the back of this book. Additionally, a separate online document (http://oceanexplorer.noaa.gov/okeanos/edu/collection/wdwe_ngss.pdf) illustrates individual lesson support for the Performance Expectations and three dimensions of the Next Generation Science Standards and associated Common Core State Standards for Mathematics and for English Language Arts & Literacy. This information is provided to educators as a context or point of departure for addressing particular standards and does not necessarily mean that any lesson fully develops a particular standard, principle or concept.

Lessons also include links to other relevant lesson plans from the NOAA Office of Ocean Exploration and Research, as well as the Ocean Explorer Web site (<http://oceanexplorer.noaa.gov/>). Educators who use the ***Okeanos Explorer* Education Materials Collection** should regularly check the Education Page on the *Okeanos Explorer* Web site (<http://oceanexplorer.noaa.gov/okeanos/edu/welcome.html>) for the latest information about new education offerings and professional development opportunities.

Welcome aboard!

Mel Goodwin, PhD
Marine Biologist and Science Writer



Notes:

