



GEMS® Curriculum Sequences

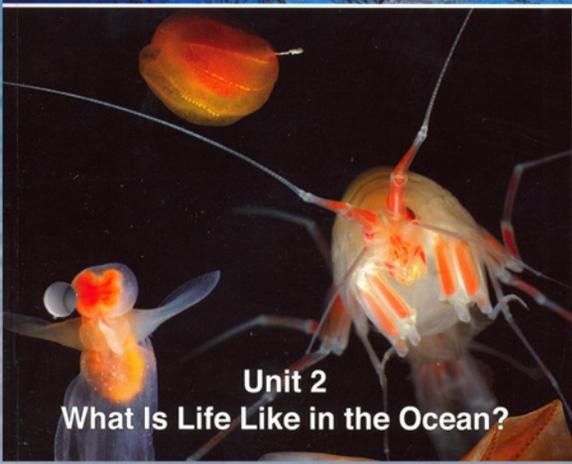
# Ocean Sciences Sequence for Grades 3-5

Introduction, Science Background,  
Assessment Scoring Guides

Lawrence Hall of Science • University of California, Berkeley



Unit 1  
What Kind of Place Is the Ocean?



Unit 2  
What Is Life Like in the Ocean?



Unit 3  
How Are Humans and the Ocean  
Interconnected?

# OCEAN SCIENCES SEQUENCE FOR GRADES 3–5

Teacher's Guide

## Introduction, Science Background, Assessment Scoring Guides



Great Explorations in Math and Science (GEMS®)

Lawrence Hall of Science  
University of California at Berkeley

*Ocean Sciences Sequence for Grades 3–5* is a collaboration between the Great Explorations in Math and Science (GEMS) Program and the Marine Activities, Resources & Education (MARE) Program, both of the Lawrence Hall of Science, University of California at Berkeley, and the Institute of Marine and Coastal Sciences (IMCS) of Rutgers University

**I**t is with great pleasure that I introduce to you the GEMS® *Ocean Sciences Sequence for Grades 3–5*. I am certain that these materials, developed with funding from the National Oceanic and Atmospheric Administration (NOAA) Office of Education, will help your students to uncover important science concepts about the ocean. More importantly, I am also certain that these materials will delight your students and inspire them to continue their own investigations of the ocean and the rest of the natural world.

The curriculum gives students the opportunity to make their own discoveries about the amazing life forms in the ocean and the ways the ocean influences all of our daily lives. It also allows students to ride along with Oscar Schofield, Josh Kohut, and myself on one of the most exciting oceanographic expeditions of our scientific careers—the first crossing of the Atlantic by an autonomous underwater glider! This is the way classroom science should be!

*Ocean Sciences Sequence for Grades 3–5* was developed by the Lawrence Hall of Science (LHS) at the University of California at Berkeley, a national leader in the development of K–12 inquiry-based science instructional materials. LHS partnered with the Rutgers University Institute for Marine and Coastal Sciences where Oscar, Josh, and I go to work each day in the COOL (Coastal Ocean Observing Laboratory) Room. This unique partnership addresses the critical need to provide students with inquiry-based experiences related to the big ideas in ocean sciences. The experiences in this curriculum sequence were developed by scientists, science educators, and educational researchers, piloted by the developers in local California classrooms, and then field tested by 70 teachers nationwide to ensure their effectiveness and broad applicability. In short, these activities work and are highly engaging.

In coastal states across the country—despite the important role that the ocean plays in driving Earth systems and influencing our history, culture, and economy—concepts about the ocean are not commonly taught in grades K–12. LHS and Rutgers have created an unprecedented opportunity to provide students with approximately 25 hours of the highest quality of instruction about ocean concepts that are aligned with state and national science education standards. Whether you live in the desert, atop the Rocky Mountains, or along one of our great shorelines, the ocean plays a huge role in your present and will play an even bigger role in your future.

In this time of melting ice caps, increasing ocean temperatures, declining fisheries, and ocean acidification, ocean exploration and research are advancing at an unprecedented rate and have been acknowledged as a matter of great national importance, akin to the space program of the 1960s. Ocean observing, remote sensing, advanced robotics, and computer modeling are daily revising what we thought we knew and influencing our lives and futures. It is critical to have ocean sciences fully represented in the K–12 science curriculum. Students in your classrooms today will no doubt be among the generation discovering solutions to our greatest challenges. One of your students might well inherit Oscar's, Josh's, or my control station in the COOL Room!

In 2004, NOAA, the National Science Foundation-funded Centers of Ocean Sciences Education Excellence, National Geographic Society, National Marine Educators Association, the College of Exploration, and the Lawrence Hall of Science convened a series of meetings to define the most important ideas that the public should understand about the ocean. Those meetings, and the input of hundreds of scientists and educators, resulted in the publication of two community consensus documents—*Ocean Literacy: The Essential Principles of Ocean Sciences K–12* and *Ocean Literacy Scope and Sequence for Grades K–12*. These documents lay out the essential ideas in ocean sciences that all students should understand by the end of grade 12. *Ocean Sciences Sequence for Grades 3–5* is based on these documents.

We are committed to working with teachers to overcome the mile-wide, inch-deep syndrome, and so we want to be clear that we are not providing you with a list of new ocean sciences concepts to add to your already overstuffed curriculum. *Ocean Sciences Sequence for Grades 3–5* addresses core science concepts found in the science standards of most states and reinforces those concepts to reflect the true complexity of the natural world, including the tremendous influence of the ocean on living things, Earth systems, and Earth processes. There are aspects of life in the ocean and of ocean processes that are quite unique and unlike their counterparts on land and in the atmosphere. In some cases, using ocean examples can simply provide a fuller understanding of a complex concept; in other cases, the omission of ocean examples can lead to misconceptions or even factual incorrectness. This curriculum provides a new and refreshing perspective on teaching your standards.

I hope that you have as much fun teaching these materials as I did helping to develop them. I hope every child in the United States has the opportunity to learn about the ocean from them.

*Scott Glenn, Coastal Ocean Observation Lab, Rutgers University, received his doctorate in 1983 from the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution Joint Program where he studied continental-shelf processes specializing in storm-driven sediment transport. He worked at Shell Development forecasting extreme wind, wave, and current conditions for oil exploration and at Harvard University on forecasting the Gulf Stream for the U. S. Navy. For the past 20 years, Scott has been a Professor of Marine and Coastal Sciences at Rutgers University. His research and education programs develop and utilize modern remote-sensing and robotic technologies combined with predictive models to explore the world ocean. His research is supported by numerous federal programs, including the NOAA-led U. S. Integrated Ocean Observing System (IOOS), the NSF Ocean Observing Initiative (OOI), the NSF Centers for Ocean Science Education Excellence (COSEE), and the DHS Center of Excellence for Port Security, resulting in over 120 publications. He has won several teaching awards, including Rutgers' first Scholar-Teacher Award, Rutgers Outstanding Undergraduate Advisor, and, most recently, the Carnegie/CASE 2010 New Jersey Professor of the Year. In 2009, Scott led the international team of scientists and students that flew the first robotic underwater glider across an ocean basin (from Tuckerton, New Jersey, to Baiona, Spain) after 221 days at sea.*

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We are extremely grateful to all the contributors, advisors, and reviewers and their institutions listed below for their invaluable help. Each of them generously provided their time and their scientific and pedagogical expertise. These partners and advisors reviewed drafts, sat around the table during the development process, and provided expert guidance. We deeply appreciate their commitment to science education and their willingness to be our go-to scientists and science educators.

### Special Science Advisors

**Dr. Scott Glenn** and **Dr. Josh Kohut**, Coastal Ocean Observation Lab, Department & Institute of Marine and Coastal Sciences, School of Environmental and Biological Sciences, Rutgers University. Their role as present-day explorers responsible for the first successful trans-Atlantic crossing of an unmanned underwater vehicle (a glider) served as the inspiration for the related activity and student readings. They applied their scientific expertise in physical oceanography in their final draft review of Unit 1: What Kind of Place Is the Ocean?

**Dr. John Manderson**, Research Fisheries Biologist, Behavioral Ecology Branch, National Marine Fisheries Service, NOAA. He took the helm on providing advice and a review of Unit 2: What Is Life Like in the Ocean? John's insightful perspective provided inspiration for the focus on habitats and for the idea explored in Unit 1: What Kind of Place Is the Ocean? that the ocean consists of a series of layers defined by light, temperature, and salinity. John coined the term *organized water* to describe this layering, and the project benefitted in multiple ways from his clever way with descriptive words.

**Dr. David Mountain**, retired NOAA scientist from the National Marine Fisheries Service, reviewed Unit 3: How Are Humans and the Ocean Interconnected? and was especially helpful in the development and review of the activities about fisheries. He enthusiastically helped us access all our fisheries' maps and data sets from the Northeast Fisheries Science Center's trawl survey data/mapping interface, which inspired Session 3.3: Investigating Overfishing.

**Dr. Drew Talley**, Professor, University of San Diego, marine ecologist, biological oceanographer, and scientist at the National Estuarine Research Reserve (NERR), San Francisco/Elkhorn Slough. Drew was always ready to respond with expert advice to even the most off-the-wall scientific questions and to help in any endeavor.

### Additional Final Draft Reviewers

**Claire Fackler**, National Education Liaison, and **Michiko Martin**, Education and Outreach Division Chief of the NOAA Office of National Marine Sanctuaries, were especially helpful in their review of Unit 3: How Are Humans and the Ocean Interconnected? They provided extremely helpful advice regarding the importance of Marine Protected Areas.

**Lynn Whitley**, Director of Education, Wrigley Institute for Environmental Studies and Sea Grant Program, Co-Director COSEE-West, University of Southern California and Sea Grant Education Network, reviewed Unit 3: How Are Humans and the Ocean Interconnected?

**Carrie Ferraro**, Institute for Marine and Coastal Sciences, Rutgers University, reviewed all three units.

## Technology Development

**Sage Lichtenwalner** and **Janice McDonnell**, of the Institute for Marine and Coastal Sciences, Rutgers University, and **Ivar Babb** and **Michael McKee** of the National Undersea Research Center, University of Connecticut, were instrumental in the development of the DVD, which accompanies the curriculum.

## Additional Scientists and Educators Participating as Advisors in the Initial Development

The following scientists and advisors were instrumental in helping to refine the concepts and scope and sequence of the curriculum at our first Scientist–Educator Partner Meeting: **Anne Ball**, NOAA Coastal Services Center; **Sharon Walker**, NOAA-Sea Grant Special Projects, Education Officer; **Marc Dantzker** and **David Brown**, Cornell University; **Susan Brady**, Education and Public Outreach Director, Lawrence Berkeley Laboratory; and **Sarah Schoedinger**, Program Officer, NOAA Office of Education.

## Special Thanks

**Scott Glenn**, Coastal Ocean Observation Lab, Rutgers University, for his tireless work to study and protect the oceans, to help spread ocean literacy, and his willingness to write the foreword for this curriculum.