GRADE 5 UNIT 4 OVERVIEW

The Land Beneath the Sea

Introduction

Until the 1860s, it was commonly assumed that life in deep oceans was not possible below 300 fathoms (1800 ft. or 550 m) due to the lack of sunlight penetrating the deep ocean and the presumed lack of primary producers (i.e., plants). This assumption was subsequently dispelled when sea life was dredged up from depths of 517 fathoms (3100 ft. or 950 m). Chemosynthesis, the process of converting the energy produced during chemical reactions into food, takes the place of photosynthesis in the deep ocean and is carried out by bacteria in this deep, dark ecosystem.

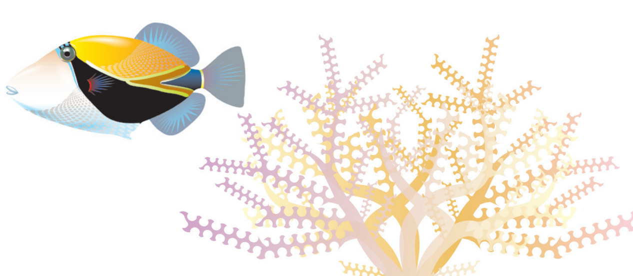
Early attempts at exploring the seafloor used lead-weighted line techniques to measure ocean depths and obtain sediment and organism samples. Those techniques provided inadequate snapshots of ocean bottom topography. Seafloor exploration has improved in recent years since the introduction of sonar technology, which allows profiling and measurements of undersea features and accurate mapping. Additional underwater technologies used today include remotely operated vehicles, autonomous vehicles, and manned deep-diving submersibles.

In this unit, students are introduced to the concept that Earth is not solid, and that its crust floats on magma. They learn that crust sections (tectonic plates) flow over or under, and toward or away from, each other. They also discover that colliding plates at converging boundaries create earthquakes, mountain ranges, valleys, deep trenches, and island chains, while plates at diverging boundaries create rift valleys and oceans.

Students compare major underwater landmass features, finding that Hawai‘i’s *Mauna Kea* – not Mount Everest – is the world’s highest mountain. Students also model seafloors, using shoeboxes and other materials, and are prompted for answers based on modeling observations and notes from their journals. They also engage in whole-class read-aloud exercises, familiarizing themselves with terms, processes, and associated undersea features. Based on recorded plate movements, students log directions in which the plates are moving, and predict where the above sea level landmasses may be in a million years.

Students’ understanding of undersea processes is assessed during question and answer exercises requiring students to consult data they compiled throughout this unit.

Multibeam mapping of seafloor today is used to create accurate bathymetric maps. They will learn about sonar and single beam mapping, then, why and how multibeam mapping has now taken its place.



At A Glance

Each Lesson addresses HCPS III Benchmarks. The Lessons provide an opportunity for students to move toward mastery of the indicated benchmarks.

ESSENTIAL QUESTIONS	HCPS III BENCHMARKS	**LESSON,** *Brief Summary,* Duration
How does the internal structure of the Earth affect the movement of Earth's crust to create land features?	Science Standard 2: The Nature of Science: SC.5.2.1: Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world. Language Arts Standard: LA.5.1.1: Use new grade-appropriate vocabulary learned through reading print and online resources and word study, including meanings of roots, affixes, word origins LA.5.1.2: Use a variety of grade-appropriate print and online resources to research a topic LA 5.4.1: Write in a variety of grade-appropriate formats for a variety of purposes and audiences LA 5.6.1: Use speaking and listening skills to fill a prescribed role in group activities LA 5.6.2: Give informal presentations or reports to inform.	**Lesson 1: The Earth is Cracking Up** This lesson introduces the concept that the Earth is not solid, but that the crust is like a thin skin floating on top of a hot taffy-like body of magma. This skin is cracked, and each section moves over and under other sections as well as toward and away from the other sections, all of which are movements that create mountains, valleys, island chains, volcanoes, and earthquakes. Four 45-minute periods
What are the major bathymetric features of the ocean? How are bathymetric features and topographic features similar and different from each other in terms of size and formation?	Science Standard 2: The Nature of Science: SC.5.2.1: Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.	**Lesson 2: Mountains, Valleys, and Plains, Oh My!** In this lesson, students will learn about the basic topography of the ocean bottom (bathymetry when under water), and compare some of the major bathymetric features under the ocean with major topographic features on land. Two 45-minute periods

ESSENTIAL QUESTIONS	**HCPS III BENCHMARKS**	**LESSON,** *Brief Summary,* Duration
How can models and simulations help us to understand features of remote areas, such as the seafloor? How did early scientists use technology and math to develop scales for maps and navigational charts?	Science Standard 2: The Nature of Science: SC.5.2.1: Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world. Math Standard 4: Fluency with Measurements MA.5.4.1: Convert simple units within a system of measurement.	**Lesson 3: Seafloor Profiling** In this lesson, students will model a seafloor with shoeboxes and wood blocks, map the seafloor using bamboo skewers, plot the data as a line graph, thereby making a profile of their seafloor, and identify geological features on the profile. Then, the shoebox seafloor models are exchanged among the student groups; each group discovers the new shoebox ocean that they have been given. Three 45-minute periods
Why is multibeam mapping the best way to chart the seafloor?	Science Standard 2: The Nature of Science: SC.5.2.1: Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world.	**Lesson 4: Multibeam Mapping** In this lesson, students will learn why accurate maps are important and how they are being made using new technologies that go way beyond the old line and sinker method. They will learn about sonar and single beam mapping, then why and how multibeam mapping has now taken its place. They will then use a multibeam map of the major Hawaiian Islands to answer a series of questions. One 60-minute period

*“Hawaii Content & Performance Standards III Database.” Hawaii Department of Education. June 2007. Department of Education. 17 Dec. 2007.

Benchmark Rubric

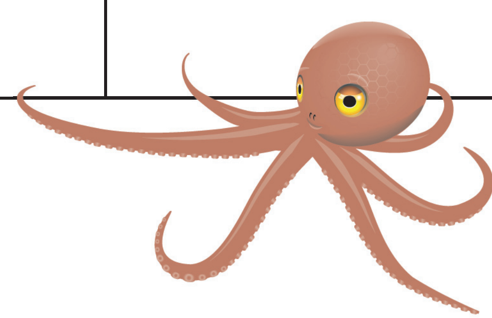
I. HCPS III Benchmarks*

Below is a general Benchmark Rubric. Within each lesson, there are other assessment tools and additional rubrics specific to the performance tasks within each lesson.

Topic		**Unifying Concepts and Themes**	
Benchmark SC.5.2.1		Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Consistently select and use models and simulations to effectively represent and investigate features of objects, events, and processes in the real world	Use models and/or simulations to represent and investigate features of objects, events, and processes in the real world	With assistance, use models or simulations to represent features of objects, events, or processes in the real world	Recognize examples of models or simulations that can be used to represent features of objects, events, or processes

Topic		**Vocabulary and Concept Development**	
Benchmark LA.5.1.1		Use new grade-appropriate vocabulary learned through reading print and online resources and word study, including meanings of roots, affixes, word origins	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use new grade-appropriate vocabulary, with fluency, precision, and accuracy	Use new grade-appropriate vocabulary, with minimal difficulty and no significant errors	Use new grade-appropriate vocabulary, with difficulty and a few significant and/or many minor errors	Use new grade-appropriate vocabulary, with great difficulty and many significant errors or rarely use new vocabulary

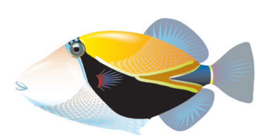
Topic		**Locating Sources/ Gathering Information**	
Benchmark LA.5.1.2		Use a variety of grade-appropriate print and online resources to research a topic	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use substantive information from an extensive variety of grade-appropriate print and online resources to thoroughly research a topic	Use relevant information from a variety of grade-appropriate print and online resources to research a topic	Use some relevant information from a few grade-appropriate print and online resources to research a topic	Use very little relevant information from grade-appropriate print and online resources to research a topic



Topic		Range of Writing	
Benchmark [LA.5.4.1]		Write in a variety of grade-appropriate formats for a variety of purposes and audiences.	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Insightfully adapt writing to grade-appropriate formats for a variety of purposes and audiences	Adapt writing to grade-appropriate formats for a variety of purposes and audiences	Write with some adaptation to grade- appropriate formats for a variety of purposes and audiences	Write with little adaptation to grade-appropriate formats for a variety of purposes and audiences

Topic		Discussion and Presentation	
Benchmark [LA.5.6.1]		Use speaking and listening skills to fill a prescribed role in group activities	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use speaking and listening skills to fill a prescribed role in group activities, in a highly effective way	Use speaking and listening skills to fill a prescribed role in group activities	Use some speaking and listening skills that assist in filling a prescribed role in group activities, in a limited way	Use irrelevant speaking and listening skills that do not relate to a prescribed role in group activities

Topic		Discussion and Presentation	
Benchmark [LA.5.6.2]		Give informal presentations or reports to inform	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Give highly effective informal presentations or reports that clearly inform	Give effective informal presentations or reports to inform	Give marginal informal presentations or reports that somewhat inform	Give ineffective informal presentations or reports that do not inform



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<tr><td colspan="2">Topic</td><td colspan="2">Measurement Attributes and Units</td></tr>
<tr><td colspan="2">Benchmark MA.5.4.1</td><td colspan="2">Convert simple units within a system of measurement (e.g., millimeters to centimeters, feet to yard, quarts to gallons, gram to kilogram, minutes to hours, days to weeks)</td></tr>
<tr><td colspan="4">Rubric</td></tr>
<tr><td>Advanced</td><td>Proficient</td><td>Partially Proficient</td><td>Novice</td></tr>
<tr><td>Convert simple units within a system of measurement, with accuracy</td><td>Convert simple units within a system of measurement, with no significant errors</td><td>Convert simple units within a system of measurement, with a few significant errors</td><td>Convert simple units within a system of measurement, with some significant errors</td></tr>
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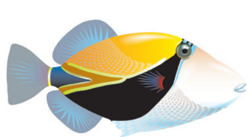
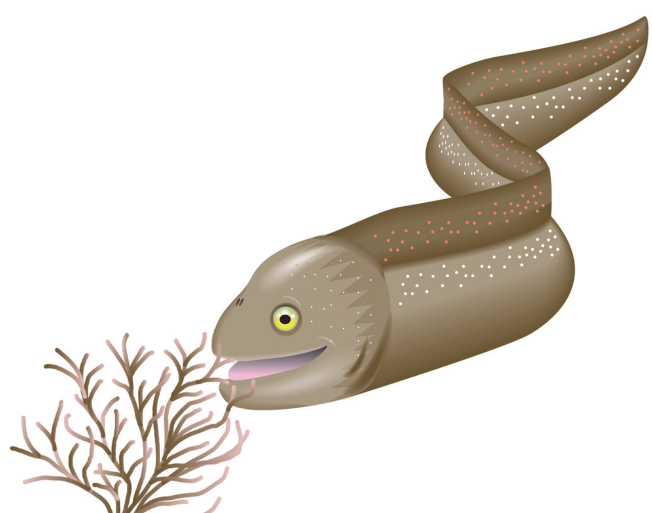
II. General Learner Outcomes*

Below is a list of the Hawai‘i Department of Education (HIDOE) General Learner Outcomes (GLOs). Each unit of the lessons from the Sea Curriculum addresses the GLOs. Within some lessons, there is more specific mention of individual GLOs with specific pertinence.

I. Self-directed Learner (The ability to be responsible for one’s own learning.).
II. Community Contributor (The understanding that it is essential for human beings to work together.).
III. Complex Thinker (The ability to demonstrate critical thinking and problem solving.).
IV. Quality Producer (The ability to recognize and produce quality performance and quality products.).
V. Effective Communicator (The ability to communicate effectively.).
VI. Effective and Ethical User of Technology (The ability to use a variety of technologies effectively and ethically.).

** “Hawai‘i Content & Performance Standards III Database.” Hawai‘i Department of Education. June 2007. Department of Education. 17 Dec. 2007.*





Science Background for the Teacher

Note: Bolded words found within this section are defined in the Science Background for the Teacher Glossary. The footnotes refer to the references found in the Science Background for Teacher Bibliography at the end of this section.

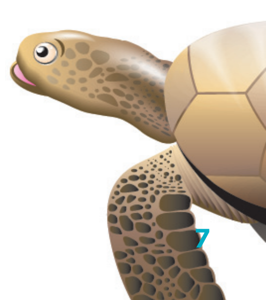
What are the basic seafloor features? (Lesson 1)

The seafloor is divided into two main regions: the **continental margins** and the deep-sea floor itself. Continental margins are the boundaries between **continental crust** and **oceanic crust**, and can be further divided into the continental shelf, the continental slope, and the continental rise. The continental shelf is the shallowest part of the continental margin and is the biologically richest part of the ocean with the most life. Extending outward from the continents, the continental shelf varies in width from less than 1 km (.62 mi.) on the Pacific Coast of South America to more than 750 km (466 mi.) on the Arctic coast of Siberia. The continental slope generally begins at depths of 120 to 200 m (394 to 656 ft.), but can be as deep as 400 m (1312 ft.), and gradually descends down at an average slope of three degrees to the seafloor. **Submarine canyons** beginning on the continental shelf and created by rivers and glaciers during past times of low sea levels cut across the continental slope, channeling sediments from the continental shelf to the deep-sea floor. The continental rise consists of a thick layer of sediment piled up on the seafloor at the base of submarine canyons.

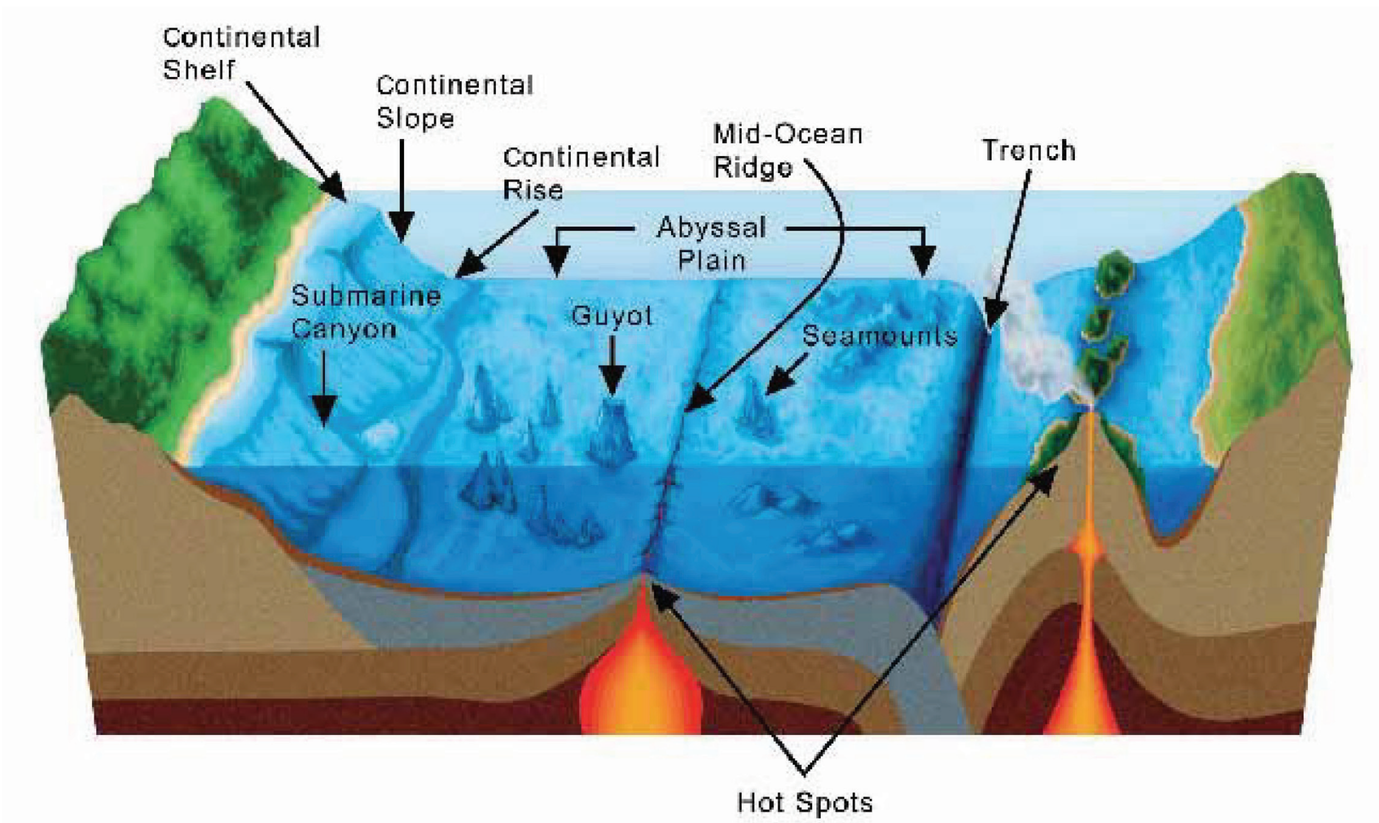
The majority of the deep seafloor lies at depths of 3,000 – 5,000 m (9,842-16,404 ft.). These great depths have made it difficult for scientific study, and little is known about this vast area. The deep seafloor is known as the **abyssal plain**, which rises at a gentle slope of less than one degree toward the mid-ocean ridge. Although relatively flat, abyssal plains contain several features, including plateaus, rises, submarine channels, and low rounded hills less than 1,000 m (3,281 ft.) high called **abyssal hills**. In some places, deep **trenches** are found along the edges of the abyssal plain. For example, the deepest place on Earth is 11.7 km (7.27 mi.) below sea level and is located in the Mariana trench in the western North Pacific Ocean. Also scattered throughout the abyssal plain are extinct underwater volcanic mountains called **seamounts**. **Guyots**, common in parts of the Pacific, are the remainder of volcanic islands that were eroded to flat-topped features by wave and wind action and then sank to become flat-topped seamounts.

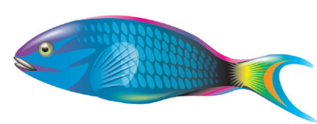
Extending 2,900 km (1,802 mi.) above the Northwestern Hawaiian Islands lies the Emperor Seamount Chain, consisting of more than 80 identified inactive underwater volcanoes. These inactive volcanoes, guyots, and seamounts, may have once been volcanic islands, but are now submerged due to erosion of the features, sinking of the **lithosphere** into the **mantle** under the weight of the island, and sea level rise. Hot spots are areas under the sea floor where mantle material can force its way through the lithosphere, forming a new seamount directly above it. The volcanic seamount *Lōʻihi* is currently forming near a hot spot at the southeast end of the Hawaiian Archipelago. *Lōʻihi* lies 45 km (28 mi.) east of the Big Island's southernmost tip, rising more than 2,450 m (8,000 ft.) above the seafloor, and 969 m (3,178 ft.) below the sea surface. Currently, *Lōʻihi* is taller than Washington State's Mount St. Helens when measured from the seafloor.

Recently discovered in 1977, **hydrothermal vents** are deep-sea hot springs, which generally form along the mid-ocean ridge system. The mid-ocean ridge system forms a nearly continuous range of mountains that wind around the Earth, making it the longest mountain range in the world and the largest geological feature on Earth. At the center of the ridge, the plates are moving apart creating a depression known as the **central rift valley**. Cold seawater seeps down through crevices in the floor and sides of the valley and gets heated to high temperatures by hot mantle material. Once heated,



the water forces its way back up through the crust and emerges through a hydrothermal vent. The water seeping through cracks in the crust dissolves a variety of minerals, mainly sulfides, which form mineral deposits around the vents as the hot water rapidly cools upon contact with the very cold, deep seawater. Since the original discovery, hydrothermal vents have also been found behind trenches. A unique ecosystem thrives around the vents. Organisms here have developed special adaptations in order to live in the cold, harsh, and otherwise chemically toxic environment surrounding the vents. For additional information concerning hydrothermal vents and their amazing ecosystems, see http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/oceanography_recently_revealed1.html.





How was the ocean floor studied years ago? (Lesson 2)

Studying the ocean floor was an almost impossible task until the introduction of recent technological advances. Prior to the introduction of these advances, scientists had few tools available to them. Early studies of the ocean floor primarily consisted of measuring the depth of the ocean and collecting sediment samples. Successive depth measurements, also called **soundings**, were conducted by lowering a weighted line (plumb line) into the water and noting when the tension on the line slackened. The depth, or distance to the seafloor, was assumed to be equal to the length of line that had to be let out before the weight hit the bottom. Soundings were taken routinely only in rivers and coastal waters. Deep-ocean soundings were rare, because they took a long time to perform and could be highly inaccurate. Ocean currents and vessel drift caused the line to slant as it was lowered to the bottom, causing the length of line let out to be greater than the vertical distance to the seafloor. These early measurements gave only a general map of the ocean floor and only large features could be identified.

Sediment samples were either collected with the use of wax coatings on the weights used for sounding, to which sediments clung, or through devices such as **dredges**. Dredges are net or wire baskets that are dragged across the bottom of the ocean to collect loose bulk material, surface rocks, shells, and associated organisms. In the late 1860s, dredge samples were collected from 517 **fathoms**, which dispelled the popularly accepted hypothesis by Edward Forbes, an English marine biologist, that life in the seas did not extend below 300 fathoms. However, the early techniques of soundings and sediment samples provided only small snapshots of the ocean floor. For historical quotes of deep-sea exploration and the technologies used over the past 300 years, see:
http://www.oceanexplorer.noaa.gov/history/quotes/soundings/soundings.html
http://www.oceanexplorer.noaa.gov/history/quotes/tech/tech.html

How is the ocean floor studied today? (Lessons 3 and 4)

Sonar (Sound Navigation and Ranging) is the basis of modern day investigation of the seafloor using sound energy to measure depth and distance in the ocean. Sonar uses sound to measure distances in water through a technique called **echo sounding**. With echo sounding, a pulse of sound sent from a ship travels to the seafloor and bounces back to a receiver on the ship. The time between sending and receiving the pulse is then used to calculate water depth at that point. During World War II, improvements in sonar technology led to continuous echo sounding, in which pulses were sent within short intervals providing a continuous profile of the seafloor along the ship's track. **Sidescan sonar** was introduced in the 1950s. With sidescan sonar, an instrument is towed below the surface of the water behind a ship and sends out a fan of pulses extending to either side of the ship's track. This technology provided the first photograph-like views of the seafloor. It also provided data on the composition of the seafloor. Hard materials reflect back more sound than soft materials, which show up as light and dark areas on the sidescan image. Sediment samples can then be taken to confirm bottom composition. However, sidescan technology is limited, because it does not provide information about depth, and the exact location of the instrument being towed is not known.

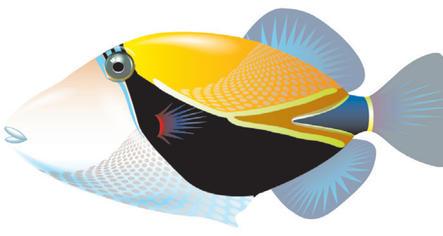
The limitations of earlier systems were improved upon with the advent of high-resolution **multibeam** swath-mapping systems developed in the 1990s. With multibeam systems, a fan of sound is sent out from an instrument mounted on the hull of the ship. Sound reflected back from the seafloor is recorded through narrow receivers set at different angles. Multibeam systems are able to detect depth differences as small as tens of centimeters. In addition to depth data, these systems also collect data on the amount of sound energy intensity returned from the seafloor. Because the instrument is mounted on the ship's hull, high-resolution multibeam mapping can provide positional information on seafloor locations within one meter. This technology is currently used to map and describe benthic habitat in the Northwestern Hawaiian Islands (NWHI). Conducted from the NOAA ship *Hiʻialakai*, scientists from NOAA's Pacific Islands Benthic Habitat Mapping Center and the Joint Institute of Marine and Atmospheric Science are using multibeam sonars in ongoing research to characterize the coral reef ecosystems of the Pacific. The research provides both bathymetric data (data on depth of the seafloor) and *backscatter data*, which provides information on the nature and composition of the seafloor. Since 2002, more than 41,000 km^2 (25,470 mi^2.) of bottom habitat has been mapped in the NWHI. For additional information concerning seafloor mapping, see http://oceanexplorer.noaa.gov/explorations/03fire/background/mapping/mapping.html.

While seafloor mapping provides information on bathymetry and composition, other technologies are required to get a first-hand look at the ocean floor. Remotely operated vehicles (ROVs) are a below-the-surface system tethered to a surface vessel or a manned submersible. The tether is the umbilical cord between the ROV and the operator; it supplies power and transmits information over an electrical or fiber-optic cable. ROVs use video, electronic-digital, and still cameras accompanied by lights to explore their environment. Depending on their mission, ROVs may be equipped with mechanical hands to manipulate objects as well as other sensors, such as sonar, temperature, and salinity monitors. The operator controls the ROV as it cruises over the seafloor. The ROV sends data to the operator and receives back directions to change position, manipulate or retrieve objects, or to use cameras and other sensors.

Autonomous underwater vehicles (AUVs) are independent, mobile, instrument platforms equipped with sensors. They are not tethered to another vessel and, therefore, their range of movement is greater than that of ROVs. AUVs may be linked acoustically to an operator on a surface vessel, or they may be programmed to complete surveys and take samples with little or no human supervision. Many of these vehicles are small, less than 25 kg (50 lb.), and have specialized capabilities and restricted depth ranges. Other vehicles work effectively in deep water and in harsh environments, such as under ice.

Manned deep-diving submersibles offer another opportunity to explore the ocean's depths. The NOAA-established program at the University of Hawaiʻi's Hawaiʻi Underwater Research Laboratory (HURL) currently has two submersibles, the Pisces IV and V, which are supported from the research ship R/V *Kaʻimikai o Kanaloa*. These submersibles can dive up to 2,000 m (6,561 ft.) below the ocean's surface. Along with an ROV that can dive to 3,000 m, HURL uses these state-of-the-art vehicles to study a variety of ocean research topics. The Habitats, Ecosystems, and Fisheries Resources Program focuses on seamount ecosystems and the biological and physical factors important in their maintenance, with particular emphasis on assessing the status of protected species, and how seamount ecosystems support commercial, or potentially commercial, fishery resources, such as fishes, corals, and crustaceans. The Submarine Volcanic Processes Program studies the geology, geophysics, geochemistry, and biology of volcanic processes and their implications for island development. *Lōʻihi* Volcano, just off the Big Island of Hawaiʻi, is their main site for monitoring these processes using an Ocean Bottom Observatory. Other research programs being led by HURL include coral reefs and coastal processes. For additional information concerning submersibles and underwater research programs, refer to http://www.soest.hawaii.edu/HURL/.

To listen to an interview with John Wiltshire of NOAA's HURL regarding technology used to monitor island formation, please visit http://www.earthsky.org/interviewpost/water/john-wiltshires-undersea-laboratory-explores-expanding-hawaii or listen to the podcast included with this unit.



Science Background for the Teacher Glossary

abyssal hills: low, rounded submarine hill less than 1,000 meters high.
abyssal plain: flat, ocean basin floor extending seaward from the base of the continental slope and continental rise.
benthic habitat: bottom environments with distinct physical, geochemical, and biological characteristics. Benthic habitats vary widely depending upon their location and depth, and they are often characterized by dominant structural features and biological communities. The term "benthic" refers to anything associated with or occurring on the bottom of a body of water.
bathymetric map: maps that show depths below sea level (also called charts).
bathymetry: the measurement of depths of water in oceans, seas, and lakes.
central rift valley: a depression in the mid-ocean ridge.
continental crust: the solid masses of the continents; composed primarily of granite.
continental margin: the zone separating the continents from the deep-sea bottom, usually subdivided into shelf, slope, and rise.
continental shelf: the zone bordering a continent, extending from the line of permanent underwater immersion to the depth at which there is a marked, or rather steep descent to the great depths.
continental slope: the relatively steep downward slope from the continental shelf break to the deep ocean.
continental rise: long, broad elevation that rises gently and generally smoothly from the seafloor.
dredge: net or wire baskets that are dragged across the bottom to collect loose bulk material, surface rocks, shells, and organisms associated with the seafloor.
echo sounding: the use of sound pulses to measure the distance to the bottom of the seafloor by means of sound waves.
fathom: a unit of length used to measure water depth, equal to 6 ft. or 1.8 m.
guyot: flat-topped seamount that was once a volcanic island that eroded and sank.
hot spots: generally localized plumes of volcanism not found near subduction zones.
hydrothermal vent: a fissure in the Earth's crust from which heated water rises.
lithosphere: outer, rigid portion of the Earth; includes the continental and oceanic crust and the upper part of the mantle.
mantle: main volume of the Earth between the crust and the core; increases in pressure and temperature with depth.
mid-ocean ridges: oceanic mountain ranges where Earth's tectonic plates are gradually moving apart.
multibeam sonar: specialized sonar system that provides fan-shaped coverage of the seafloor; similar to side scan sonar, but the output data is in the form of depths.
oceanic crust: a thick mass of basalt rock that lies under the ocean floor.
plate tectonics: geologic theory that combines the concepts of seafloor spreading and continental drift to explain the large-scale movement of the Earth's crust.
seamounts: isolated, extinct volcanic peak that rises at least 1,000 meters from the seafloor.
side scan sonar: a technique for mapping the morphology of the seafloor; the output data creates images of the seafloor. Along with seafloor samples, it is able to provide an understanding of the surface geology of the seabed.
sounding: the historical nautical term for measuring depth of the ocean.
submarine canyons: grooves in the continental shelf and slope leading down to the ocean bottom.
trenches: long, narrow depressions of the ocean floor where Earth's tectonic plates are forced together, causing the underlying plate to sink back into the mantle in the process of subduction.

Science Background for the Teacher - Bibliography

1-3 Science background information condensed and/or compiled from the following sources:

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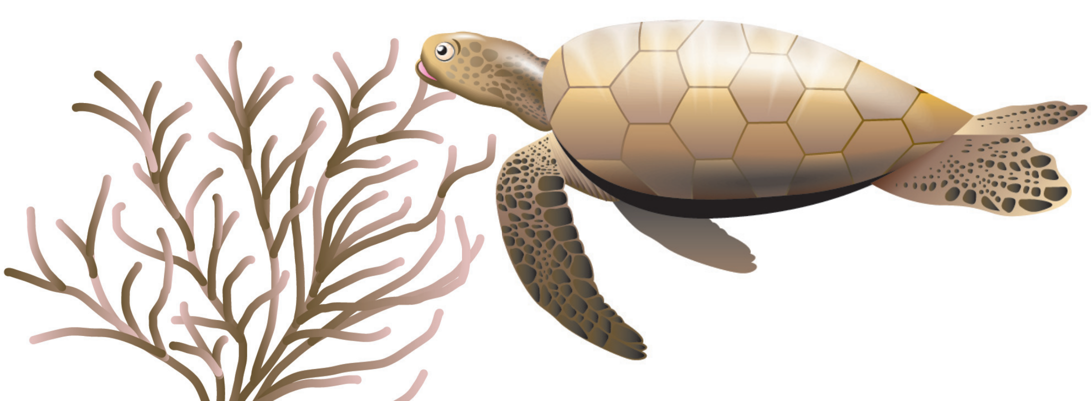


NOAA Resources

Below is a list of resources compiled by the Outreach Education Office of the National Oceanic and Atmospheric Administration. The science standards and the ocean literacy principles addressed in this unit were used as a guideline in selecting the following resources. To access the print resources listed below, contact NOAA's Outreach Education Office directly:

Outreach Unit
NOAA Office of Public and Constituent Affairs
1305 East West Highway #1W514
Silver Spring, MD 20910
Phone: (301) 713-1208
Email: NOAA-OUTREACH@noaa.gov
http://www.education.noaa.gov/

Resources:

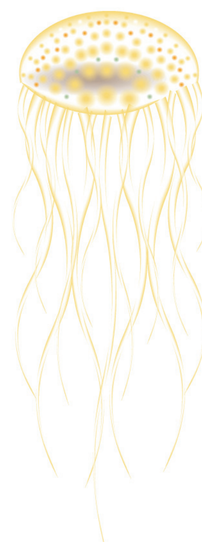
- "Surface of the Earth" poster from NOAA NGDC.
  http://www.ngdc.noaa.gov/mgg/announcements/announce_surface.html
- What is Benthic Habitat?
  http://www.csc.noaa.gov/benthic/start/what.htm
- NOAA Ocean Service Education: Elementary Education Seafloor Mapping:
  http://www.oceanservice.noaa.gov/education/seafloor-mapping/toc.html
- NOAA Coastal Services Center Benthic Habitat Mapping Touch Tank:
  http://www.csc.noaa.gov/benthic/resources/species/species.php
- NOAA Coastal Services Center Benthic Habitat Mapping Image Gallery:
  http://www.csc.noaa.gov/benthic/resources/gallery/gallery.htm

OCEAN LITERACY ESSENTIAL PRINCIPLES

1. The Earth has one big ocean with many features.
   - 1b. An ocean basin's size and shape and features (islands, trenches, mid-ocean ridges, rift valleys) vary due to the movement of Earth's lithospheric plates. Earth's highest peaks, deepest valleys, and flattest vast plains are all in the ocean.

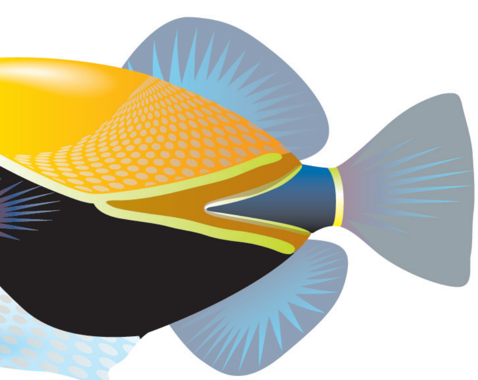
7. The ocean is largely unexplored.
   - 7d. New technologies, sensors and tools are expanding our ability to explore the ocean. Ocean scientists are relying more and more on satellites, drifters, buoys, subsea observatories and unmanned submersibles.
   - 7f. Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, and physicists, and new ways of thinking.

Lesson 1: 1b.
Lesson 2: 1b.
Lesson 3: 7d.
Lesson 4: 7d. 7f.



CLIMATE LITERACY ESSENTIAL PRINCIPLES

There is no appropriate alignment of Climate Literacy Essential Principles to the unit lessons.



Glossary of Cooperative Learning Techniques

In an effort to maximize student engagement and learning, the NOAA Sea Earth and Atmosphere curricular resources were designed using cooperative learning techniques. This guide defines the expectations for implementation of each technique.

What is Cooperative Learning?

Cooperative learning may be broadly defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a shared or common goal. According to Johnson, Johnson and Holubc, (1994): "Cooperative learning is the instructional use of small groups through which students work together to maximize their own and each other's learning." In classrooms where collaboration is practiced, students pursue learning in groups of varying size: negotiating, initiating, planning and evaluating together. Rather than working as individuals in competition with every other individual in the classroom, students are given the responsibility of creating a learning community where all students participate in significant and meaningful ways. Cooperative learning requires that students work together to achieve goals which they could not achieve individually.

Jigsaw

To Jigsaw materials refers to the use of a strategy in which each student on a team receives only a piece of the material that is to be learned in which that student becomes the "expert." Once the material is learned each member of the team takes a turn teaching the other members their assigned content. This type of dynamic makes the students rely on the other members of their team to learn all of the material.

Think-Pair-Share

This four-step discussion strategy incorporates wait time and aspects of cooperative learning. Students (and teachers) learn to LISTEN while a question is posed, THINK (without raising hands) of a response, PAIR with a neighbor to discuss responses, and SHARE their responses with the whole class. Time limits and transition cues help the discussion move smoothly. Students are able to rehearse responses mentally and verbally, and all students have an opportunity to talk.

Numbered Heads

This structure is useful for quickly reviewing objective material in a fun way. The students in each team are numbered (each team might have 4 students numbered 1, 2, 3, 4). Students coach each other on material to be mastered. Teachers pose a question and call a number. Only the students with that number are eligible to answer and earn points for their team, building both individual accountability and positive interdependence.

KWL Chart

A pre-assessment tool consisting of three vertical columns. Students list what they "Know" about a topic. What they "Want" to know about a topic. The last column students share what they have "Learned" about a topic.

KWL CHART

Be sure to bullet your list.

Use content words only (nouns, verbs, names of people and places, dates, numbers, etc.).

WHAT DO I KNOW?	WHAT DO I WANT TO KNOW? *or* WHAT DO I WANT TO SOLVE?	WHAT HAVE I LEARNED?
•		•

Role Cards

Assign students to cooperative learning groups. Once students are in their groups the teacher will hand out premade role cards that will help each member of the group contribute to the completion of the given task. Before roles are assigned, the teacher should explain and model the task as well as the individual roles for students so that they know and understand how his/her individual role will contribute to the success of the group completing the task. When this technique is used, taking on a different role will aid in student proficiency.

Example of role cards:

Role Card #1

Facilitator:

Makes certain that everyone contributes and keeps the group on task.

Role Card #2

Recorder:

Keeps notes on important thoughts expressed in the group. Writes final summary.

Role Card #3

Reporter:

Shares summary of group with large group. Speaks for the group, not just a personal view.

Role Card #4

Materials Manager:

Picks up, distributes, collects, turns in, or puts away materials. Manages materials in the group during work.

Role Card #5

Time Keeper:

Keeps track of time and reminds groups how much time is left.

Role Card #6

Checker:

Checks for accuracy and clarity of thinking during discussions. May also check written work and keeps track of group point scores.

Round Table

Round table can be used for brainstorming, reviewing, or practicing while also serving as a team builder. Students sit in teams of 3 or more, with one piece of paper and one pencil. The teacher asks a question which has multiple answers. Students take turns writing one answer on the paper, then passing the paper and pencil clockwise to the next person. When time is called, teams with the most correct answers are recognized. Teams reflect on their strategies and consider ways they could improve.

Three-Step Interview

This involves structured group activity with students. Using interviews/listening techniques that have been modeled; one student interviews another about an announced topic. Once time is up, students switch roles as interviewer and interviewee. Pairs then join to form groups of four. Students take turns introducing their pair partners and sharing what the pair partners had to say. This structure can be used as a team builder, and also for opinion questions, predicting, evaluation, sharing book reports, etc.

Venn Diagram

A diagram using circles to represent sets, with the position and overlap of the circles comparing and contrasting the relationships between two given pieces of information.