Ocean Ecosystems

Abstract

What's in the ocean? Only 5% of the ocean has been explored and yet it is the largest ecosystem in the world. It affects the entire planet and this creates a great need to understand it. If we ask students what they know about the ocean, they may identify some of its components like salt, fish, and coral, and actions like waves. However, they may be less knowledgeable about how the living and physical properties of the ocean interact. In this lesson, students explore the characteristics of both the living (biotic) and non-living (abiotic) factors that make up the ocean. They will also discover how inhabitants interact and depend on each other and on the non-living components of the ocean. Students will investigate the ocean ecosystem.

Target Audience: Middle School

Next Generation Science Standards*

5-LS2; MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Learning Goals

- Understand and explain the characteristics of biotic and abiotic factors in an ocean ecosystem.
- Observe ocean ecosystems and collect data from an underwater camera to identify, classify, and analyze components of that ecosystem.
- Identify patterns of interaction and interdependence among the components of an ocean ecosystem.
- Recognize how matter and energy cycle through living and non-living parts of an ocean ecosystem.

Focus Question

What's life like in the ocean?

Key Terms

- abiotic
- biotic
- ecosystem
- salinity
- pH
- temperature
- biodiversity
- interdependence

Key Skills

- Making observations
- Collecting data
- Recognizing patterns
- Analyzing and interpreting data
- Constructing explanations
- Obtaining, evaluating, and communicating information

Background Knowledge

The ocean is a dynamic place, producing an ever-changing environment for its inhabitants. The nature of water–its ability to absorb chemicals, dissolve hard substances, and give and take heat–

makes the ocean a highly variable environment. Also, the temperature is not constant. At the equator, the water temperature is at its hottest, and it is near freezing in the polar-regions. This temperature gradient is perhaps the primary factor affecting life in the oceans, including where you find certain types of fish, mammals, invertebrates and other organisms. We also know the ocean is salty. Over millions of years, rain has dissolved rocks on the land releasing these salts, which then flow from rivers to the oceans. As water evaporates from the oceans due to the heat from the sun, it leaves behind these salts. This cycle has increased the concentration of salt to what we can 'taste' today. These physical properties of the oceans, plus others such as the pH and the oxygen content, are all important factors affecting life in the oceans. We refer to these physical and chemical factors as abiotic.

Life in the ocean, called biotic, is diverse and exists from the deepest depths to the coldest corners of the ocean. Some of the most diverse ecosystems on the planet exist in the ocean, as do some of the most unique animals. All major groups of earth's organisms are either represented in the oceans or rely on it. For example, sea birds are an integral part of some coastal ecosystems. Mammals, such as whales and dolphins, roam the ocean. Fish of all shapes and sizes are found in the shallowest tide pools along a beach and also found in the deepest depths. Sharks, as great predators, are the oceans regulators and keep balance within food webs that exist in almost every ocean habitat. Crabs, worms, and other invertebrates live in the spaces between rocks, or within the soft sediments of the oceans floor. All of these creatures interact, live together, and are predators or prey.

Where an animals lives in the ocean is related to its adaptations, abiotic factors, and other organisms that live there. Each ecosystem within the ocean is made up of a web of interactions where each organism is affected by or reliant on other organism that coexists in that space. These interactions among organisms are the links that keep an ecosystem functioning. If any of these organisms are removed from an ecosystem, a link is broken and an ecosystem will start to change or shift and could possibly collapse.

An ecosystem may also decline if the abiotic factors of the ocean begin to change. Changing temperatures, salinity, and the pH of the ocean can have profound impacts on life in the ocean. For example, due to climate change, the oceans are becoming more acidic; this change in pH affects the quality and thickness of the shells of animals and the skeletal structure of coral. When the surrounding water is more acidic than normal, the calcium carbonate (limestone) structure of shells cannot form as thick. Furthermore, already formed calcium carbonate begins to dissolve. If the limestone skeleton structure of corals begins to weaken, then corals will start to collapse. These limestone structures that coral create are a critical habitat for thousands of animal species on reefs. Without coral, these ecosystems would collapse into piles of rubble. This would leave the fish and other animals nowhere to live and thus this ecosystem would be gone.

We depend on these ecosystems and the oceans as much as it depends on us being good stewards. This interconnectedness is our most critical on the planet. The oceans provide us with food, oxygen, and it regulates our weather and temperatures. Certain ecosystems protect our coastlines by buffering them from storms and constant wave damage. Others are extremely productive, providing

us with food from a variety of sources such as fish, crabs, oysters, and other marine life. We must ensure that the balance in the ocean remains intact. We need to avoid damaging the links that are vital to maintaining these balances. For example, we can hope to maintain the oceans' ecosystems by not removing too much of any one species and by mitigating effects on the oceans' physical properties.

Materials

Science notebook
Computer with internet connection
Butcher paper
Markers
What's in the ocean? cards

Advance Preparation

Connect to the Ocean First Education Website (https://oceanfirsteducation.com/)
Identify groups of 3-4 students who will work together.
Prepare the *What's in the ocean?* cards

Potential Misconceptions

- Changing populations and population sizes within an ecosystem will not affect other components (abiotic and biotic) in that ecosystem.
- Ecosystems are a collection of organisms and do not function as a whole.
- Communities don't change over time.
- Photosynthesis does not occur in the ocean.
- Humans do not depend on the ocean.

Eliciting Prior Knowledge

1. Pose the question, "What's in the ocean?" and write the question on the board.
2. Ask students to get in groups or assign groups of 3-4 students per group.
3. Provide markers and butcher paper to each group and ask them to write down their ideas. *(hint: give a different color marker to each student in the group and share that all students should contribute their ideas. Look for all four marker colors on the paper).*
4. Ask each group to present their ideas. Record ideas on the board as each group presents. Listen for how much students know about what is in the ocean, both living and non-living components.

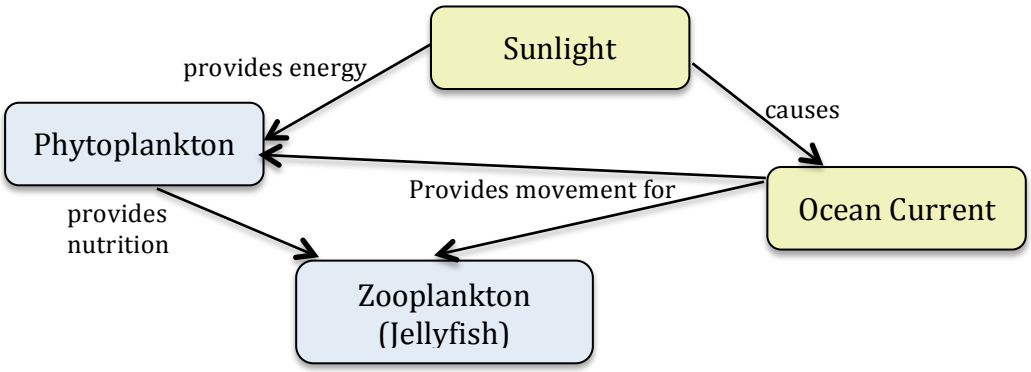
Process and Procedures (Guided strategies and sequence of learning activities)

1. Project the ecosystem video clips from oceanfirsteducation.com. *(Hint: If students have access to individual computers or tablets, you may choose to do this as an independent activity instead of whole class).*
2. Ask students to record everything they see in the video in their science notebook. Emphasize that they should have a critical eye and write down and/or draw all of their observations. Give them several minutes to record their ideas.
3. Have students compare their ideas with a partner and add any ideas that they didn't have on their own list.
4. Hand out the *What's in the ocean* cards. Ask students to review the cards and discuss the similarities and differences between their observations and what is on the cards with a partner.

5. Direct students to sort the cards in a way that makes sense to them. Then, have them write down characteristics of each group of cards. *[Hint: After a few minutes,* suggest *students sort the cards in to as few categories as possible but more than one.]*
6. Facilitate a class discussion on the characteristics of their groups of cards. Lead students in a discussion presenting biotic and abiotic factors. Share that abiotic factors might include physical and chemical elements such as water and salt and also factors that affect the ocean such as sunlight and wind.
7. Using what they learned from their observations, discussions, and the *What's in the ocean?* cards, ask students to list the components of the ocean in their science notebook. Show the example table below:

Abiotic	*Notes and other information*	*Biotic*	*Notes and other information*

8. Project another ecosystem video clip and ask students to make observations and answer the following question in their notebook.
   - What kind of interactions do you see among the biotic and abiotic components? Note the behavior and interactions of the living organisms with other living organisms, and the living organisms with non-living components. Write down detailed observations.
9. Direct students to create a concept map (i.e. bubbl.us; Inspiration; chart paper) that shows possible connections among the components of the ocean. Ask students to be sure to add the connecting words that explain the relationship. Show the example below:



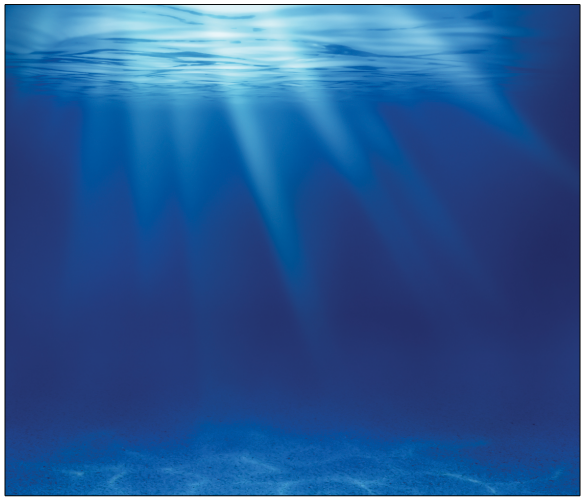
Formative assessment strategies

Listen for student discussions during the card sort and during the class discussion. Circulate around the room and check student data, observations, sketches, etc. in their science notebooks. Ask students to describe what they are learning.

Summative assessment

Write a story, comic book, or poem that describes an ecosystem using examples from your observations, the data you collected from the video clips, and your concept map. Be sure to include Key terms in your story.

Teacher Notes

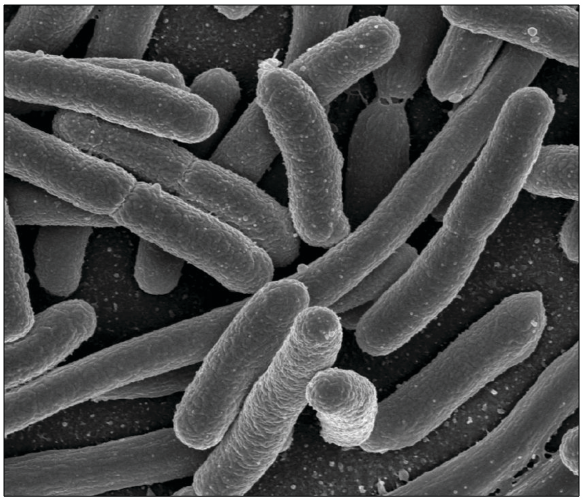
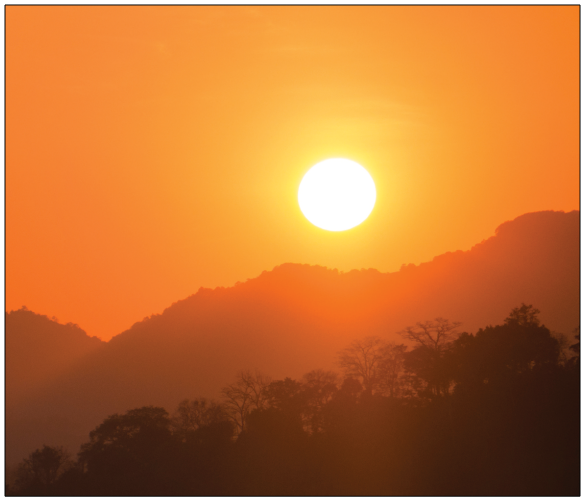
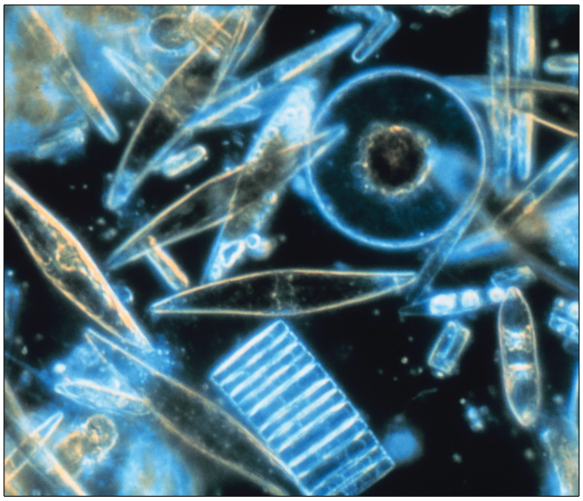


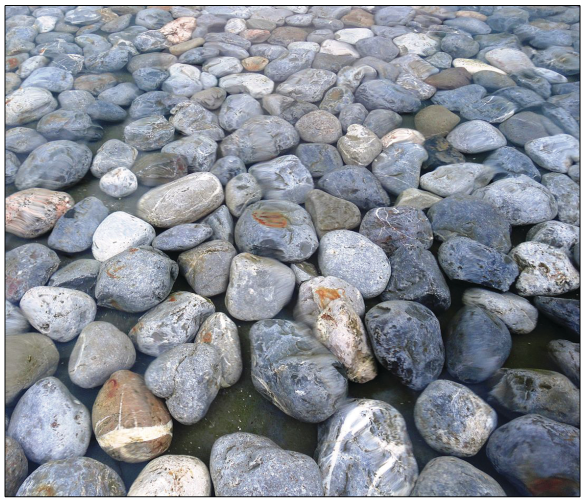
WATER

BIRDS

SALT

FISH

O_2 **OXYGEN**	 **BACTERIA**
 **SUNLIGHT**	 **PHYTOPLANKTON**

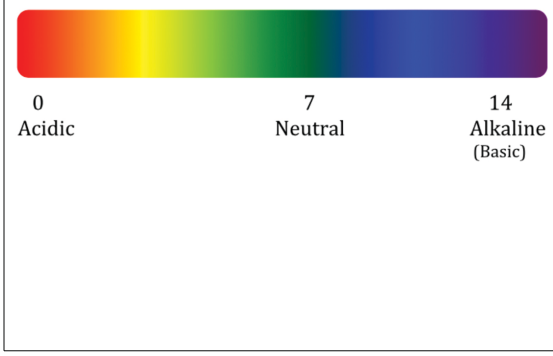


SEDIMENT
(ROCKS, MINERALS, ORGANIC MATTER)

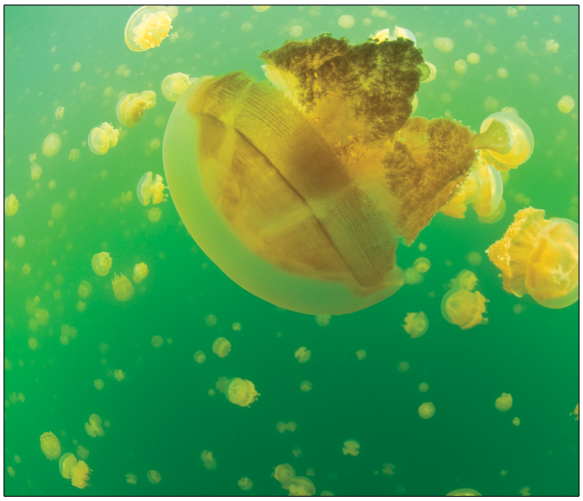
MOON

WIND

MAMMALS
(WHALE, SEA OTTER, ETC.)



pH



INVERTEBRATES

(JELLYFISH, SPONGES, MARINE WORMS)

TEMPERATURE

REPTILES

(CROCODILE, SEA SNAKES, MARINE IGUANA)

Next Generation Science Standards

Performance Expectations
5-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate an understanding can:
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.[Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

MS-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate an understanding can:
MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. [Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.[Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]

MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

Disciplinary Core Idea(s)	*Science and Engineering Practices*	*Crosscutting Concept(s)*
Grade 5 **LS2.A: Interdependent Relationships in Ecosystems** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)	• Developing and using models • Analyzing and interpreting data • Constructing explanations and designing solutions • Engaging in argument from evidence	• Patterns • Cause and effect • Energy and matter • Stability and change • Systems and System Models

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) **MS** **LS2.A: Interdependent Relationships in Ecosystems** • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1) • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1) • Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) • Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2) **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** • Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)		

Centers for Ocean Science Education Excellence, National Geographic Society, National Oceanic and Atmospheric Administration, and College of Exploration (2005). *Ocean Literacy: The Essential Principles of Ocean Sciences Grades K–12*, a jointly published brochure,
URL: www.coexploration.org/oceanliteracy/documents/OceanLitConcepts_10.11.05.pdf.

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.