Disneynature

# OCEANS

## EDUCATOR'S GUIDE

Educational Materials developed in cooperation with NATIONAL GEOGRAPHIC

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# Introduction

Disneynature OCEANS is an inspiring adventure into a liquid world few of us have ever seen before. Yet the oceans cover more than 70 percent of our planet. The second Disneynature film, OCEANS, offers an unprecedented window into this largely unexplored world as well as an extraordinary educational opportunity.

OCEANS ignites the imagination. It engages students to want to learn standards-based science content. Through this introduction to themes in the film, students will learn earth science, life science, physical science, chemistry, and geography.

This Educator Guide builds on many of the themes developed in the film and molds them into classroom lessons that correlate to your required science standards.

Disneynature OCEANS is also a great way to introduce differentiated instruction to your science lessons. Through seeing, listening, and reading, the film and this guide will improve comprehension for students at all reading levels. It will also give them more of a real-world learning experience through this multi-media approach.

OCEANS will allow students to see for themselves the wonderful cast of characters that live in this world of liquid space. They will also learn how the oceans control much of what happens on land.

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Grades 2-6 National Science Education Standards

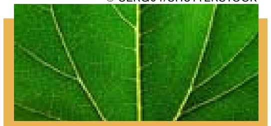
# Disneynature OCEANS

EDUCATOR'S GUIDE



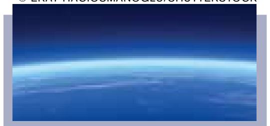
## CONTENT TOPIC AREAS





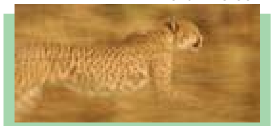
Science as Inquiry





Earth and Space Science





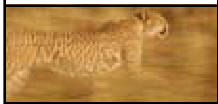
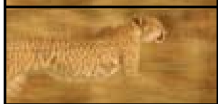
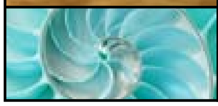
Life Science



History and Nature of Science

## Fresh Water vs Seawater: Which is More Dense?

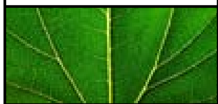
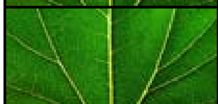
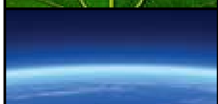
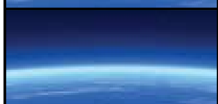
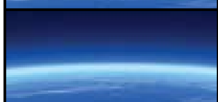
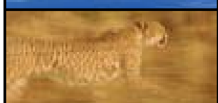
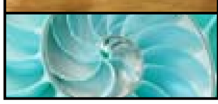
| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| Topic Area | Develop Understanding Of | Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6 |
| | Understandings about scientific inquiry | | | tasks 3, 5, & 6 | tasks 3, 5, & 6 | tasks 3, 5, & 6 |
| | Abilities necessary to do scientific inquiry | | | tasks 3, 5, & 6 | tasks 3, 5, & 6 | tasks 3, 5, & 6 |
| | Changes in earth and sky | | | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Structure of the earth system | | | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Earth in the Solar System | | | | | |
| | Characteristics in populations | | | | | |
| | Structure and function of living organisms | | | | | |
| | Regulation of behavior | | | | | |
| | Populations and ecosystems | | | | | |
| | Diversity and adaptations of organisms | | | | | |

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
|  | Matter, energy, and organization in living systems | | | | | |
|  | Behavior of organisms | | | | | |
|  | Populations, resources, and environments | | | | | |
|  | Nature of scientific knowledge | | | tasks 1-6 | tasks 1-6 | tasks 1-6 |

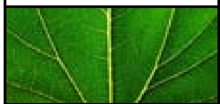
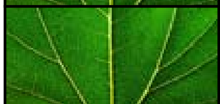
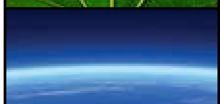
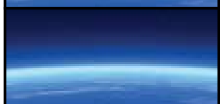
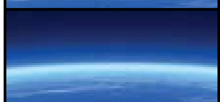
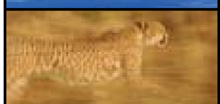
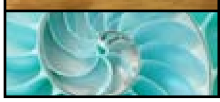
## How Big are the Oceans?

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
| | Understandings about scientific inquiry | | | | | |
| | Abilities necessary to do scientific inquiry | tasks 7&11 | tasks 7&11 | tasks 7&11 | tasks 7&11 | tasks 7&11 |
| | Changes in earth and sky | | | | | |
| | Structure of the earth system | | tasks 1-11 | tasks 1-11 | tasks 1-11 | tasks 1-11 |
| | Earth in the Solar System | | tasks 1-11 | tasks 1-11 | tasks 1-11 | tasks 1-11 |
| | Characteristics in populations | | | | | |
| | Structure and function of living organisms | | | | | |
| | Regulation of behavior | | | | | |
| | Populations and ecosystems | | | | | |
| | Diversity and adaptations of organisms | | | | | |
| | Matter, energy, and organization in living systems | | | | | |
| | Behavior of organisms | | | | | |
| | Populations, resources, and environments | | | | | |
| | Nature of scientific knowledge | | | | | |

## How the Oceans Affect Weather

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
|  | Understandings about scientific inquiry | | | | | |
|  | Abilities necessary to do scientific inquiry | | | tasks 8-9 | tasks 8-9 | tasks 8-9 |
|  | Changes in earth and sky | | | tasks 6-7 | tasks 6-7 | tasks 6-7 |
|  | Structure of the earth system | | | tasks 3-5 | tasks 3-5 | tasks 3-5 |
|  | Earth in the Solar System | | | tasks 1-2 | tasks 1-2 | tasks 1-2 |
|  | Characteristics in populations | | | | | |
|  | Structure and function of living organisms | | | | | |
|  | Regulation of behavior | | | | | |
|  | Populations and ecosystems | | | | | |
|  | Diversity and adaptations of organisms | | | | | |
|  | Matter, energy, and organization in living systems | | | | | |
|  | Behavior of organisms | | | | | |
|  | Populations, resources, and environments | | | | | |
|  | Nature of scientific knowledge | | | | | |

## What Lives in Different Ocean Zones?

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
|  | Understandings about scientific inquiry | | | | | |
|  | Abilities necessary to do scientific inquiry | | | | | |
|  | Changes in earth and sky | | | | | |
|  | Structure of the earth system | | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
|  | Earth in the Solar System | | | | | |
|  | Characteristics in populations | | tasks 4-6 | tasks 4-6 | tasks 4-6 | tasks 4-6 |
|  | Structure and function of living organisms | | | | | |
|  | Regulation of behavior | | | | | |
|  | Populations and ecosystems | | tasks 4-6 | tasks 4-6 | tasks 4-6 | tasks 4-6 |
|  | Diversity and adaptations of organisms | | tasks 4-6 | tasks 4-6 | tasks 4-6 | tasks 4-6 |
|  | Matter, energy, and organization in living systems | | | | | |
|  | Behavior of organisms | | tasks 4-6 | tasks 4-6 | tasks 4-6 | tasks 4-6 |
|  | Populations, resources, and environments | | | | | |
|  | Nature of scientific knowledge | | | | | |

## Build a Kelp Forest

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
| | Understandings about scientific inquiry | | | | | |
| | Abilities necessary to do scientific inquiry | tasks 3&6 | tasks 3&6 | tasks 3&6 | tasks 3&6 | tasks 3&6 |
| | Changes in earth and sky | | | | | |
| | Structure of the earth system | | | | | |
| | Earth in the Solar System | | | | | |
| | Characteristics in populations | tasks 1&7 | tasks 1&7 | tasks 1&7 | tasks 1&7 | tasks 1&7 |
| | Structure and function of living organisms | tasks 4&6 | tasks 4&6 | tasks 4&6 | tasks 4&6 | tasks 4&6 |
| | Regulation of behavior | | | | | |
| | Populations and ecosystems | task 1 | task 1 | task 1 | task 1 | task 1 |
| | Diversity and adaptations of organisms | task 1 | task 1 | task 1 | task 1 | task 1 |
| | Matter, energy, and organization in living systems | Extension Activity | Extension Activity | Extension Activity | Extension Activity | Extension Activity |
| | Behavior of organisms | task 6 | task 6 | task 6 | task 6 | task 6 |
| | Populations, resources, and environments | Task 8 & Extension Activity 6 | Task 8 & Extension Activity 6 | Task 8 & Extension Activity 6 | Task 8 & Extension Activity 6 | Task 8 & Extension Activity 6 |
| | Nature of scientific knowledge | | | | | |

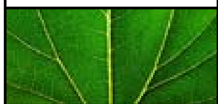
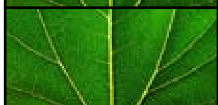
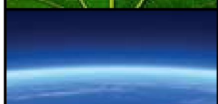
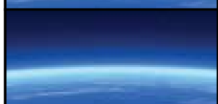
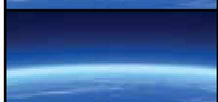
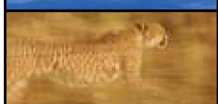
## Coral Reef Color

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
| | Understandings about scientific inquiry | | | | | |
| | Abilities necessary to do scientific inquiry | | | | | |
| | Changes in earth and sky | | | | | |
| | Structure of the earth system | | | | | |
| | Earth in the Solar System | | | | | |
| | Characteristics in populations | task 2 | task 2 | task 2 | task 2 | task 2 |
| | Structure and function of living organisms | | | | | |
| | Regulation of behavior | | | | | |
| | Populations and ecosystems | task 5 | task 5 | task 5 | task 5 | task 5 |
| | Diversity and adaptations of organisms | tasks 1 & 4 | tasks 1 & 4 | tasks 1 & 4 | tasks 1 & 4 | tasks 1 & 4 |
| | Matter, energy, and organization in living systems | | | | | |
| | Behavior of organisms | task 3 | task 3 | task 3 | task 3 | task 3 |
| | Populations, resources, and environments | | | | | |
| | Nature of scientific knowledge | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 |

## What Do Oceanographers Do?

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
| | Understandings about scientific inquiry | | | | | |
| | Abilities necessary to do scientific inquiry | | | | | |
| | Changes in earth and sky | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Structure of the earth system | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Earth in the Solar System | | | | | |
| | Characteristics in populations | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Structure and function of living organisms | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Regulation of behavior | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Populations and ecosystems | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Diversity and adaptations of organisms | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Matter, energy, and organization in living systems | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Behavior of organisms | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Populations, resources, and environments | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 | tasks 2-7 |
| | Nature of scientific knowledge | tasks 1-7 | tasks 1-7 | tasks 1-7 | tasks 1-7 | tasks 1-7 |

## Glowing in the Dark

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
|  | Understandings about scientific inquiry | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 |
|  | Abilities necessary to do scientific inquiry | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 | tasks 1 - 12 |
|  | Changes in earth and sky | | | | | |
|  | Structure of the earth system | | | | | |
|  | Earth in the Solar System | | | | | |
|  | Characteristics in populations | task 12 | task 12 | task 12 | task 12 | task 12 |
|  | Structure and function of living organisms | task 12 | task 12 | task 12 | task 12 | task 12 |
|  | Regulation of behavior | | | | | |
|  | Populations and ecosystems | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 |
|  | Diversity and adaptations of organisms | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 |
|  | Matter, energy, and organization in living systems | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 |
|  | Behavior of organisms | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 |
|  | Populations, resources, and environments | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 | tasks 9 - 12 |
|  | Nature of scientific knowledge | | | | | |

## Food Chains

| National Science Education Standards | | Task Number by Grade | | | | |
|---|---|---|---|---|---|---|
| **Topic Area** | **Develop Understanding Of** | **Grade 2** | **Grade 3** | **Grade 4** | **Grade 5** | **Grade 6** |
| | Understandings about scientific inquiry | | | | | |
| | Abilities necessary to do scientific inquiry | | | | | |
| | Changes in earth and sky | | | | | |
| | Structure of the earth system | | | | | |
| | Earth in the Solar System | | | | | |
| | Characteristics in populations | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Structure and function of living organisms | | | | | |
| | Regulation of behavior | | | | | |
| | Populations and ecosystems | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Diversity and adaptations of organisms | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Matter, energy, and organization in living systems | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Behavior of organisms | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Populations, resources, and environments | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 | tasks 1-6 |
| | Nature of scientific knowledge | | | | | |

This fur seal has climbed onto rocks, but fur seals spend most of their time in water. They can stay in the ocean for weeks at a time.

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# Physical Characteristics of the Oceans

## In the Film

The Disneynature film, **OCEANS,** brings the enormous size of Earth's oceans to the big screen. Nearly everything about this liquid world is large. It covers more than 70 percent of Earth's surface. All of Earth's dry land could fit inside just one ocean—the Pacific. The deepest valleys cut through the ocean floor and the tallest mountains rise above it. Nearly everywhere you look you find life. The smallest to the largest of creatures live in the oceans. The huge scale of the oceans is almost unimaginable. Yet we've explored only about five percent of the oceans.

## Transfer of Energy

Life in the oceans depends on energy. Most energy in the ocean starts with the sun. Plants such as sea grass, and algae such as kelp, gather sunlight and use it to make food for themselves. This process is called **photosynthesis.** Because photosynthesis depends on sunlight, in the oceans it happens only near the surface. Plants and some algae on dry land use the same process to make food.

Plants and algae are called **producers** because they can make their own food. Animals, however, cannot make their own food. They depend on other organisms for food. These animals are called **consumers.**

There are three kinds of consumers—**herbivores, carnivores,** and **detritivores** or **decomposers.** Herbivores are animals that graze on plants or algae. Manatees are a good example of a marine mammal that is a herbivore. A manatee spends most of its time eating grasses, weeds, and algae. It can eat about 130 pounds of plants in only 24 hours.

Carnivores are the second kind of consumer. They eat other living animals. A fur seal is a carnivore that eats birds, fish, krill, and squid.

Detritivores, or decomposers, make up the third group of consumers. These organisms are very important in returning nutrients back to an ecosystem.

Some manatees body surf when they play.

© A COTTON PHOTO/SHUTTERSTOCK

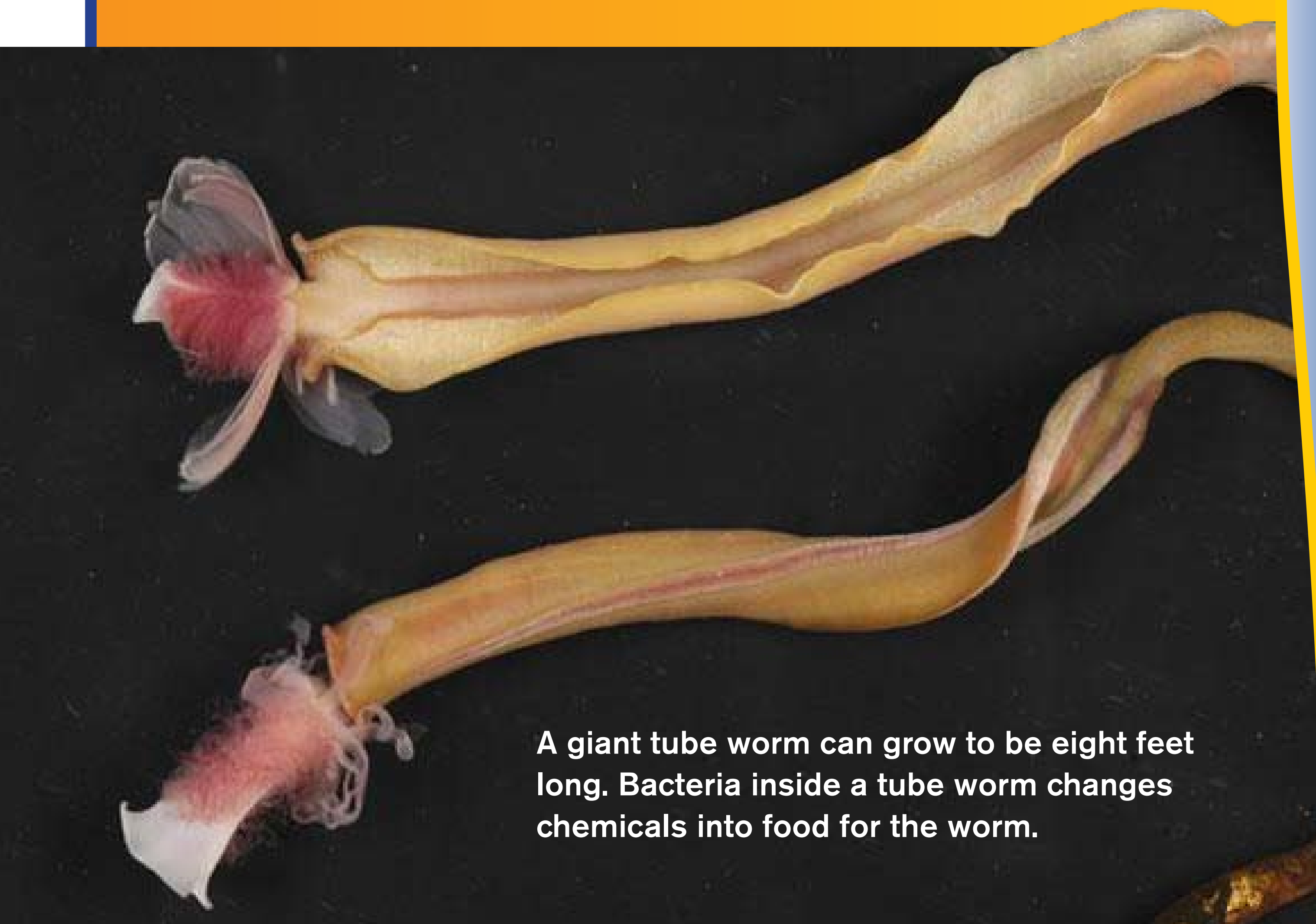
All the producers and consumers in the ocean are connected by a **food web.** A food web shows how energy is transferred from algae or plants to animals, and from animal to animal. A small part of a food web is called a **food chain.**

Near the surface of the ocean, a food chain begins with the sun. There, producers use solar energy to make food. Sunlight, however, doesn't reach deeper areas of the ocean.

Producers in the deepest part of the ocean use chemical energy to make food. For example, at hydrothermal vents, areas of the ocean floor where hot **magma** pushes up from deep inside Earth, the food chain starts with chemical energy provided by the hydrothermal vents. Bacteria convert the energy into food. This process is called **chemosynthesis.** These bacteria, which are producers, provide food for giant tube worms.

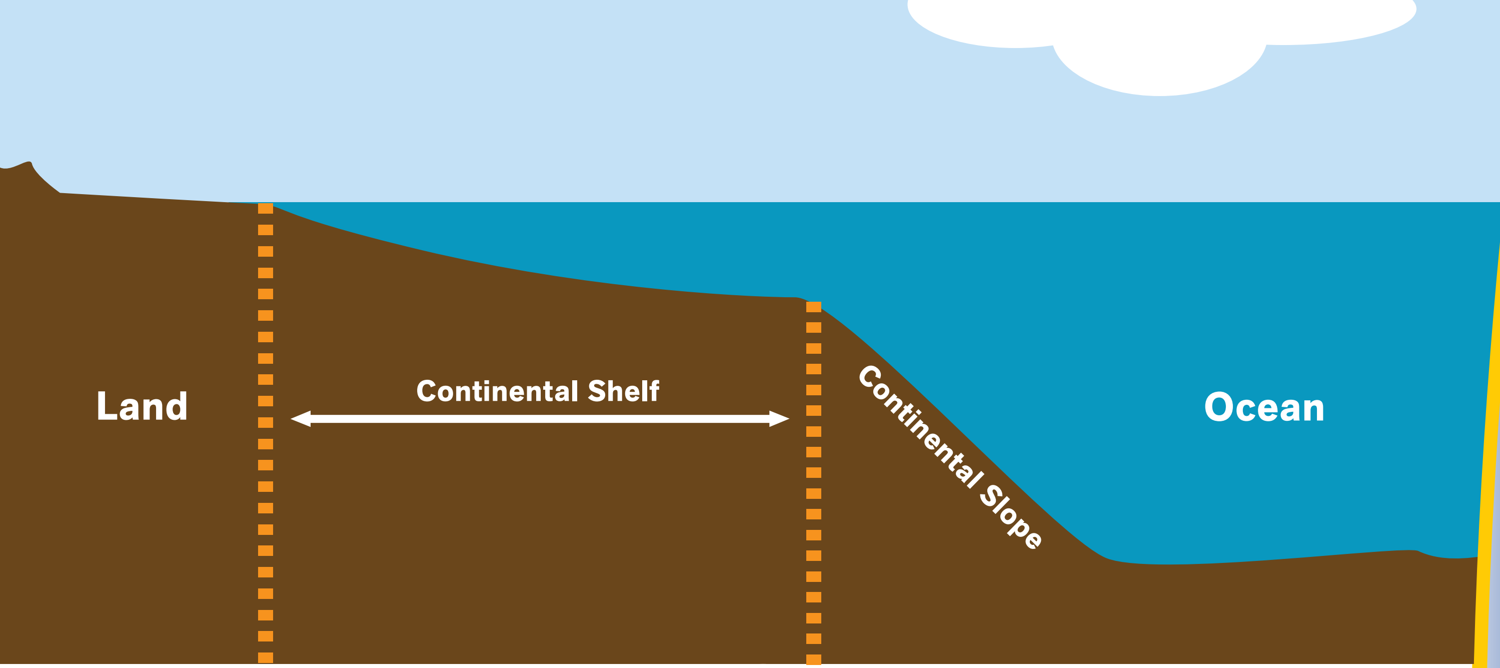
## A TUBE WORM'S FOOD CHAIN

**chemicals from vents** → **bacteria** → **giant tube worms**



A giant tube worm can grow to be eight feet long. Bacteria inside a tube worm changes chemicals into food for the worm.

NOAA/NIWA




## Land Meets Water

While the oceans cover most of Earth today, they didn't always exist. According to scientists, early Earth was one large landmass. **Volcanoes** erupted huge amounts of gases into the atmosphere. These gases combined to create water vapor. Eventually, the water vapor condensed and fell to the ground as rain. It rained for thousands of years, filling the lowest parts of the ground and making the first oceans.

Today, Earth's landmasses slowly transition into the oceans. This transition begins with the **continental shelf.** It is a gently sloping extension of the continents submerged underwater. The gently sloping continental shelf suddenly plunges downward into the **continental slope.** The continental slope extends down to the **ocean plains, mountains, ridges,** and **trenches.**

Most of these underwater geographic features are hidden from view. However, some stick above the surface in the form of **islands.** The Hawaiian Islands are great examples of this. All of these islands are actually the peaks of giant underwater volcanoes (mountains).

## Recycling Crust

The land, or **crust,** at the bottom of the ocean is different than the crust that forms Earth's landmasses. For instance, it is much younger. The oldest rocks brought up from the ocean are only about 200 million years old. This is much younger than Earth's age, 4.5 billion years.

New crust forms at the **mid-ocean ridge.** This is a giant underwater mountain range that runs along the ocean floor.

The new crust pushes outwards from the mid-ocean ridge, moving pieces of Earth's crust, called **plates.** The moving plates sometimes smash into one another. When crust that makes up the continents crashes into crust that makes up the ocean floor, a **subduction zone** forms. The crust from the ocean floor dives beneath the continental crust and melts into magma, molten rock deep inside Earth. The magma slowly makes its way back to the surface, either through a volcano on land or the mid-ocean ridge. Magma that bursts through the surface on land is called **lava.** In this way, all rocks on Earth are recycled and it makes sense that ocean rocks are younger than rocks on the landmasses.

## How Many Oceans?

How many oceans surround Earth's continents? This may sound like a simple question, but geographers do not agree on one answer. In reality, if you look at a globe or a world map, you will see that the water that surrounds Earth's continents is connected, forming one large body of water. This is called the World Ocean.

Traditionally, however, geographers have divided the World Ocean into four smaller oceans. These are the Arctic Ocean, Atlantic Ocean, Indian Ocean, and Pacific Ocean. Many geographers, including geographers at the National Geographic Society still say there are four oceans.

A number of geographers, however, refer to a fifth ocean. In 2000, the International Hydrographic Organization named it the Southern Ocean. It is made up of the waters from the southern portions of the Atlantic, Indian, and Pacific Oceans and completely surrounds Antarctica. In this sense, the fifth ocean is really comprised of part of three of the traditional four oceans.

Geographers who believe in the fifth ocean say creating a new ocean is no different than changing a country's boundaries, which happens fairly often. They also point out that the ocean is based on new knowledge gained after studying **ocean currents.** These are rivers of water that flow through the oceans. Ocean currents affect weather and climate worldwide.

The largest ocean current flows through the Southern Ocean. About 100 times more water flows through this current than flows through all the rivers on land.

## TALK IT OUT

**Explain that geographers do not always agree and have different points of view. They talk about their different opinions and try to reach agreement. Tell students to imagine that they are geographers who are trying to determine how many oceans surround Earth's continents.**

**Divide the class into three groups. Each group is to research a different number of oceans. The first group will research one World Ocean. The second group will research four oceans. The third group will research five oceans. Direct the groups to use the internet and the library to research the number of oceans. After students have finished their research, ask each group to present the evidence that supports its side. After all the groups have made their presentations, give each group time to ask questions of the other groups. Then take a class vote on the number of oceans.**

## How the Oceans Impact the Land

The ocean is so large that it affects our entire planet. It holds about 320 million cubic miles of water, roughly 97% of all Earth's water. Seawater is, on average, 3.5% salt, making it undrinkable.

The oceans absorb heat from the sun and transfer it to the atmosphere. Both the oceans and the atmosphere distribute the sun's heat around the planet. This drives global weather.

Ocean water located near the **Equator,** an imaginary line that runs around the middle of Earth, is warmer than in other areas. This is because sunlight directly hits this area. Sunlight warms the air, which warms the water.

Ocean water located near Earth's Poles is colder than ocean water located in other areas. This is because the Poles get less sunlight than other areas. The air is cooler, which keeps the water cooler.

Ocean currents are huge rivers of water that flow through the oceans. Currents can form at different levels in the ocean. Near the surface, winds and Earth's rotation causes ocean currents. The currents move in large circular paths bordered by the continents. These circular paths are called **gyres.**

Currents can carry warm or cold water. This is how ocean currents transfer heat worldwide.

The Gulf Stream is an example of one of these currents. It flows north and east out of the Gulf of Mexico, winding its way up the Atlantic Ocean, east of the United States, toward western Europe. It brings warm water from the Gulf of Mexico, which warms the air in the areas it passes through, increasing the temperature. It can also affect humidity and rainfall. As a result, much of the eastern United States and western Europe are warmer than other areas located on the same latitude.

The gyre is completed as cold water flows south and east from western Europe, south toward northwestern Africa, and then west toward the east coast of North and South America. The colder water cools these areas and makes them less tropical. As a result, eastern Florida is cooler than other areas at the same latitude.

The California Current does the same thing on the U.S. West Coast. The current flows south, bringing cool water from the north. It cools the air along the coast, which can be much warmer inland.

## Ocean Animals Need Land

Many ocean animals are connected to land, too. For example, marine iguanas and sea turtles live in the oceans and spend at least some time on land.

The marine iguana lives on the rocky coasts of the Galapagos Islands. Males dive into the water to graze on seaweed. Females can't dive as deep and must eat the seaweed exposed during low tide. Marine iguanas also have a pretty cool adaptation to salt—they are actually able to use algae to get rid of the salt they ingest by blowing it out their nose!

Sea turtles are another example of an ocean animal that depends on the land. Female green sea turtles leave the oceans for land every couple of years to lay eggs.

A green sea turtle begins its life nestled inside a leathery egg buried in a sandy nest on a beach. It struggles to push its way through the egg and then digs its way to the top of the nest with about 70-150 other hatchlings.

Once the hatchlings hit the beach, they scramble towards the water. They must make it past predators like birds, snakes, crabs, and sometimes even raccoons and dogs, in order to reach the water.

The green turtle hatchlings that survive grow to weigh about 500 pounds. Despite their immense size, green sea turtles are herbivores that mainly eat sea grass as adults. Sea grass is the only flowering plant in the oceans.

Even though green sea turtles live in the ocean, they breathe air. They generally dive for up to five minutes, then they head for the surface to inhale air. They can sleep underwater for up to five hours.

Sea turtles swim through the oceans, stopping in many habitats. A **habitat** is the place a plant or animal lives. The plant or animal gets everything it needs to survive from its habitat.

## THE DEEPEST PLACE

**Extending down to a depth of seven miles in the Pacific Ocean, the Mariana Trench is the deepest place in the ocean. It is six times deeper than the Grand Canyon.**

Activity
Grades 4-6

# Fresh Water vs. Seawater; Which is Less Dense?

## Learning Objective

To learn that fresh water is less dense than seawater.

## Tasks

1. Divide students in groups of three or four. Give each group two 10-ounce cups. Ask them to label one of them "fresh water" and the other "seawater."

2. Pour 8 ounces of fresh water into each cup labeled "fresh water." Pour 8 ounces of seawater into each cup labeled "seawater." To make the seawater, add three or four tablespoons of salt to a quart of fresh water. While real seawater is more complex than this mixture, it matches the salinity of seawater.

3. Explain to students that they are about to place an ice cube in each cup. Ask them to predict if the ice cube will melt faster in the fresh water or seawater, or if it will melt at the same rate. Have them record their predictions.

4. Distribute two ice cubes to each group. The ice cubes should be about equal in size.

5. Direct a student from each group to place one ice cube in each of the two cups at the exact same time. Have another student record the time it takes for each ice cube to melt.

6. Ask students to analyze their results. Then have them write their observations and conclusions.

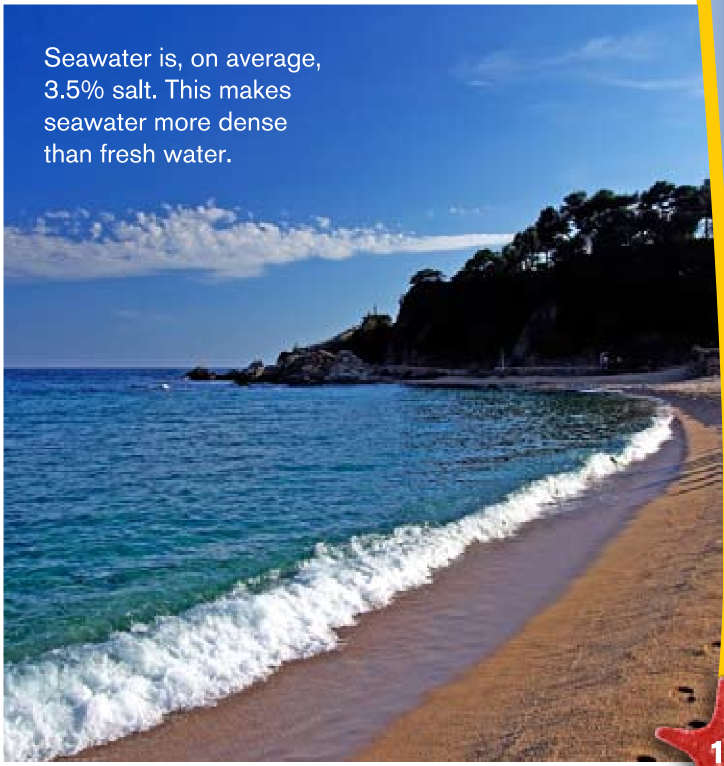
## Observations and Conclusions

The ice cube in the cup of fresh water melted faster than the ice cube in the seawater.

The water produced from the melting ice cube in the fresh water is colder than the rest of the fresh water. Cold fresh water is denser than warm fresh water, so it sinks.

In the cup with seawater, the melting fresh water forms a pool around the ice cube and doesn't sink. This is because fresh water is less dense than seawater. This pool of cool water insulates the ice cube, which causes it to melt at a slower rate than the ice cube in the fresh water.





Seawater is, on average, 3.5% salt. This makes seawater more dense than fresh water.

Activity
Grades 2-6

# How Big are the Oceans

## Learning Objective

To learn the names of the oceans and continents, and to understand that the world ocean is much larger than the continents.

## Tasks

1. Make copies of the world map on the next page and give one to each student. Display a copy of the map on a projector and point to the continents. Explain that the continents are the largest land masses on Earth. Tell students that there are seven continents. As you point to each continent, name it or ask students to name it.

2. Point out the oceans. Remind students that geographers do not agree on the number of oceans. As you point to each ocean, name it or have students name it. After students name the oceans, remind them that all the oceans are connected to form one world ocean.

3. To help students visualize the size of the ocean, tell them that they are going to make models of the world ocean and each continent.

4. Hand each group a sheet of paper and a ruler. Have them cut a square measuring 8 inches by 8 inches and color the sheet blue.

5. Explain that the square represents a scale model of the world ocean. The world ocean covers 134,000,000 square miles. The scale is approximately 1 square inch for every 2 million square miles.

6. Next, hand each group another sheet of paper measuring 8.5 x 11 inches. Tell them that they will use the sheets to cut out squares that represent the area each continent covers.

7. Write the following scale on the board so students will know how to cut out each continent. The numbers in the right column show the sizes of the squares. Please note that all numbers are rounded.

| continent/ocean | inches |
|---|---|
| World Ocean | 8.2 x 8.2 |
| Asia | 2.9 x 2.9 |
| Africa | 2.5 x 2.5 |
| North America | 2.1 x 2.1 |
| South America | 1.9 x 1.9 |
| Antarctica | 1.6 x 1.6 |
| Europe | 1.4 x 1.4 |
| Australia | 1.2 x 1.2 |

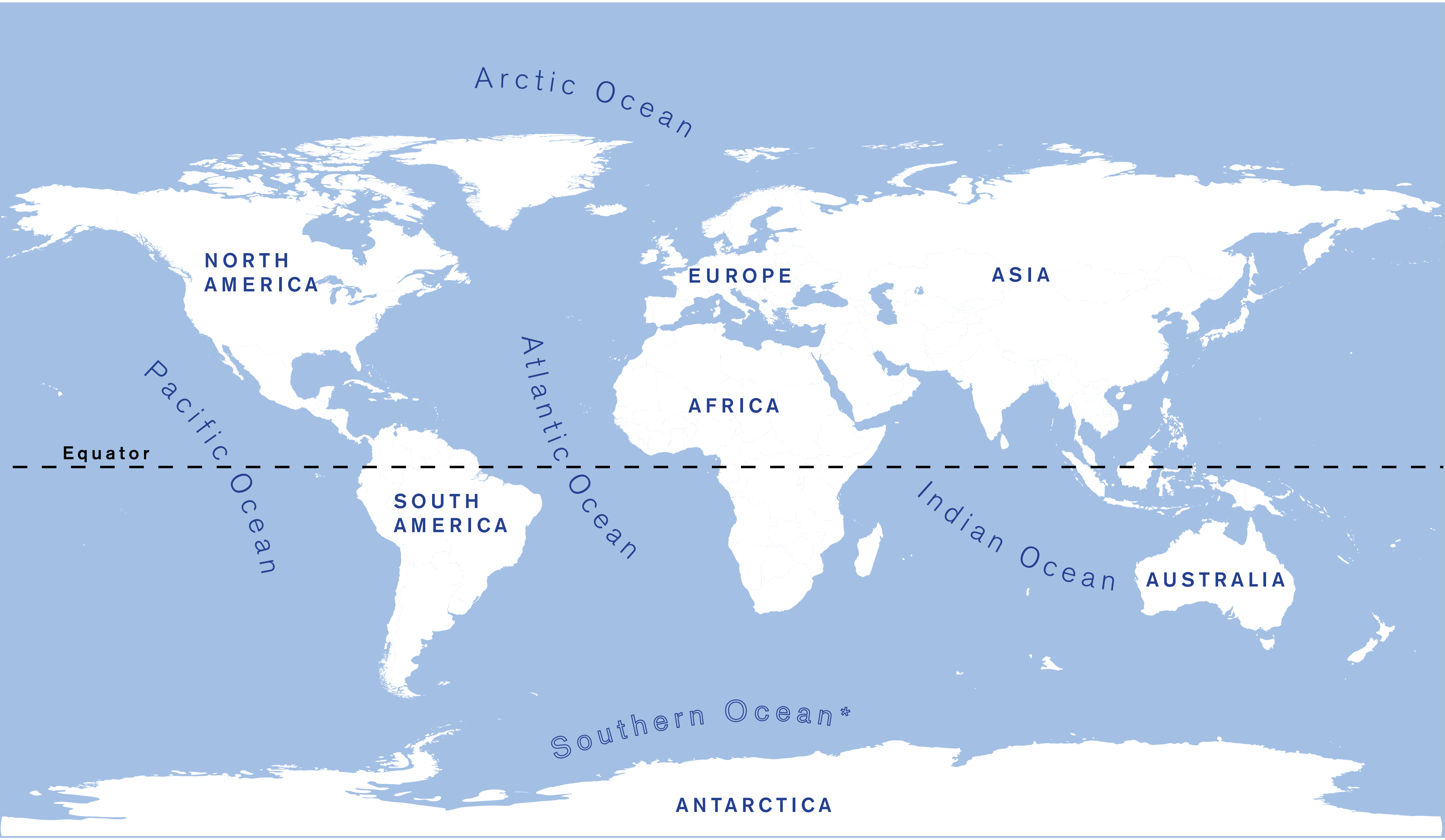
8. After students have cut out each square, have them write the continent's name on it.

9. After all the squares are cut out, have students arrange them in order from largest to smallest. Ask them if they are surprised by what they see. Many students may have thought that North America is the largest continent.

10. Have students place the squares on the large square that represents the oceans. Ask them: Which is larger—the world ocean or all the continents combined?

11. Ask students in grades 4 and 5 to estimate how much larger the world ocean is compared to the continents. Note that the combined area of the continents is 57,000,000 square miles and the oceans cover 134,000,000 square miles. So the world ocean is about three times larger than the continents.

# Explore the Oceans




*The Atlantic, Indian, and Pacific Oceans merge into waters around Antarctica. Some geographers call this area the Southern Ocean.

Activity
Grades 4-6

# How the Oceans Affect Weather

**Many students do not understand how the oceans affect weather unless they live along a coast. Yet the oceans affect weather and climate, even in areas located far from the coasts.**

## Learning Objective

To understand the relationship between the oceans and land, and how the oceans affect weather.

## Tasks

1. Direct students' attention back to the world map handout. Ask them to point to the Equator. Explain that the Equator is an imaginary line that wraps around the middle of Earth, separating the Northern Hemisphere and Southern Hemisphere. Tell them that the sun's light shines most directly on the area around the Equator. This makes the air around the Equator warmer than in other areas. The warm air warms the ocean.

2. Ask students to point to the two Poles. Explain that the Poles get less sunlight than other areas of Earth, so the air is cooler around the Poles. The cooler air chills the oceans.

3. Remind students that the oceans are much larger than the continents.

4. Distribute the world map on the next page that shows the direction that different currents flow and whether those currents are cooler or warmer than the surrounding water.

5. Tell students that ocean currents are like rivers that flow through the ocean. They carry 100 times more water than all of the rivers on dry land combined.

6. Ask students in which part of the map or globe they would expect to find warmer water. *(Around the Equator.)*

7. Direct students' attention toward one of the warm currents. Ask them if it flows towards or away from the Equator. Then point out one of the cool currents. Ask if it flows towards or away from the Equator.

8. Ask students in which direction the warmer currents generally flow. Then ask them in which direction the cooler currents flow. (They should conclude that warmer currents flow away from the Equator and cooler currents flow towards the Equator.)

9. Ask students to describe how these currents might affect the weather in the regions they flow through.

10. Ask students to explain how the currents might affect weather in the area where they live.

**Good teacher resources for this activity:**

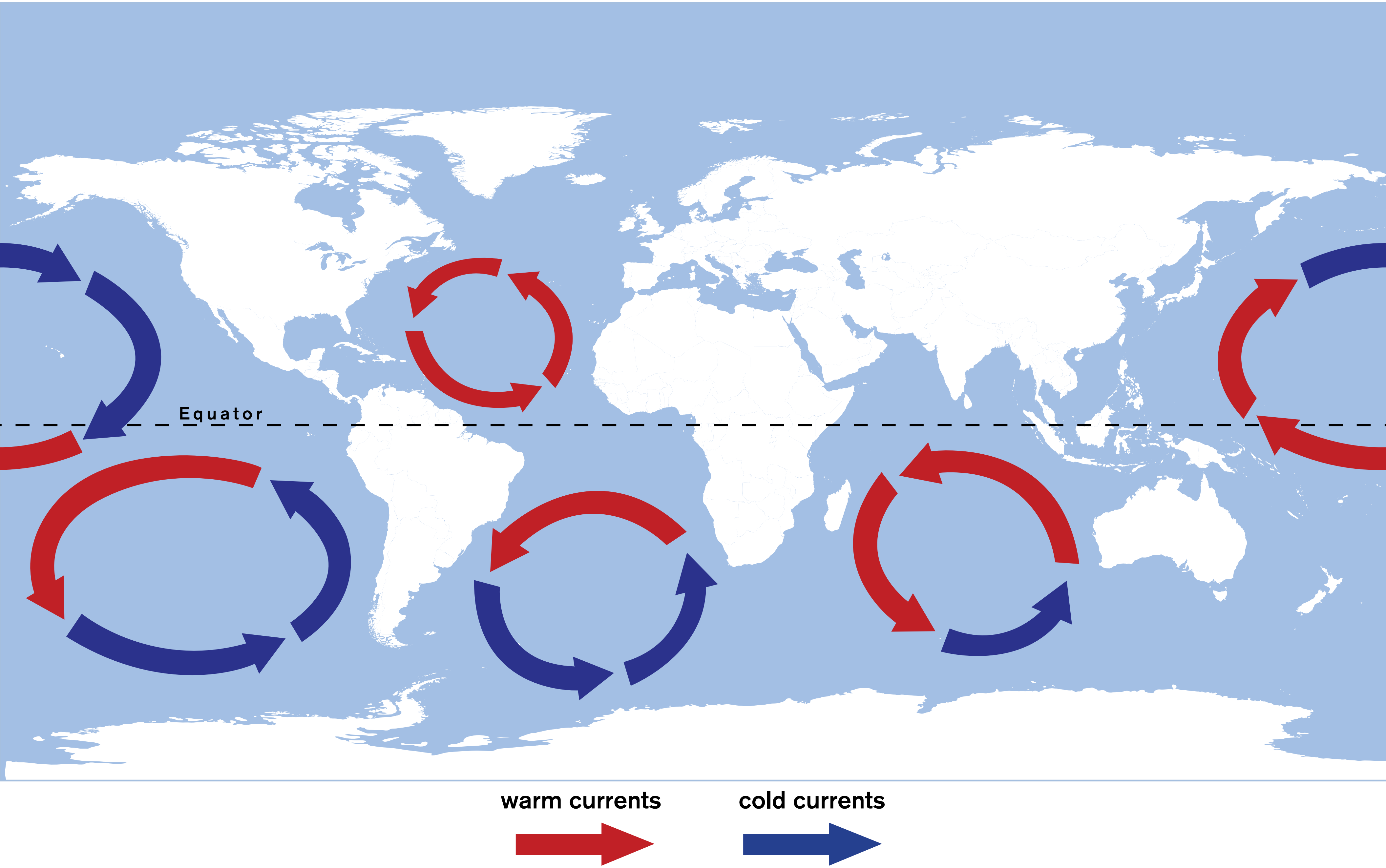
National Weather Service's Online School for Weather: http://www.srh.noaa.gov/srh/jetstream/ocean/ocean_intro.htm

Voyager Magazine from UCSD: http://explorations.ucsd.edu/Archives/Volume_8/Number_1/Vol_8_n1_Voyager.pdf

Bill Nye The Science Guy-Oceanography DVD: http://www.dep-store.com/product-p/77a43vl00.htm

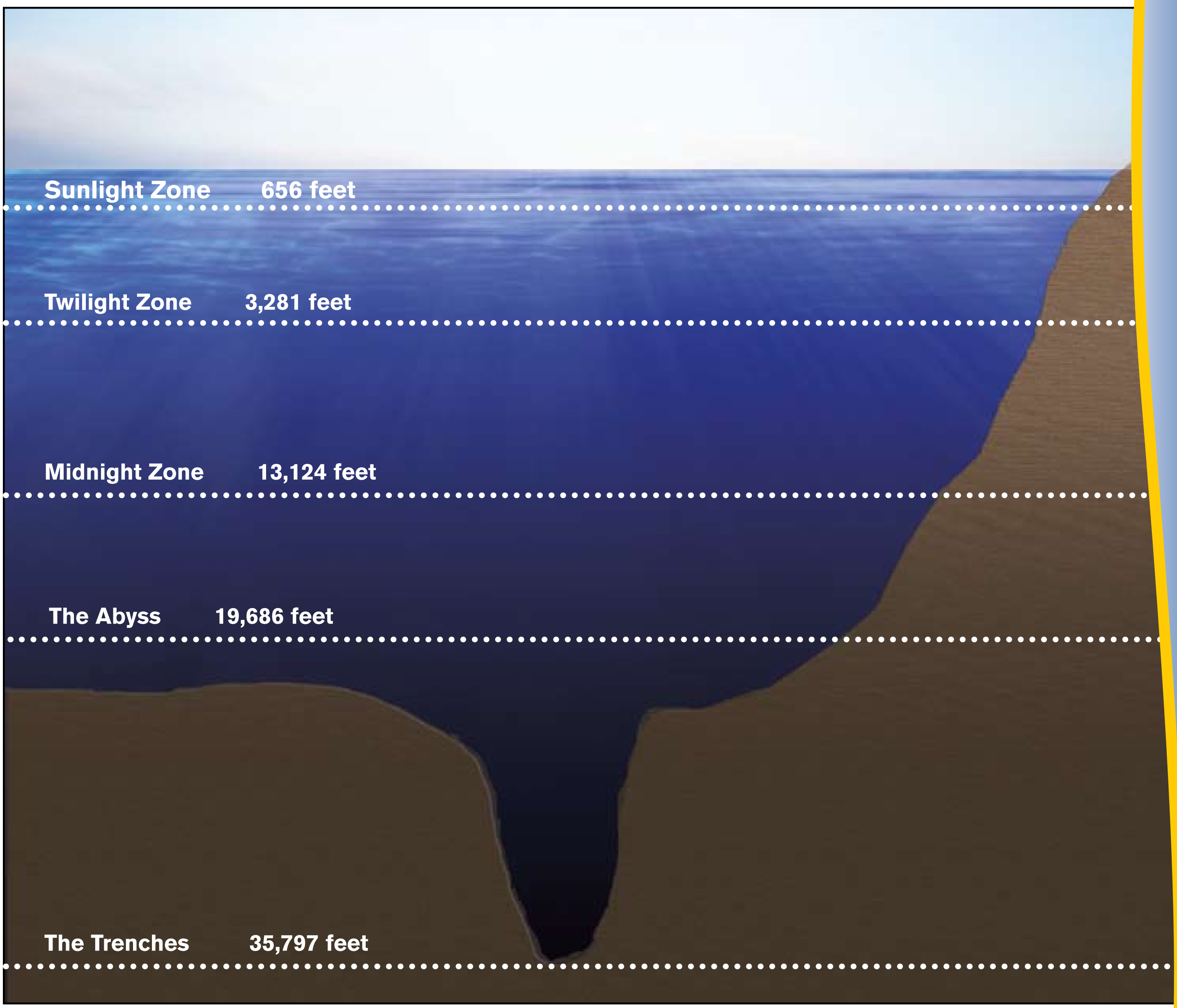
Lots of Weather Lesson Plan ideas: http://www.teachervision.fen.com/weather/teacher-resources/6675.html

# Explore Ocean Currents



# Dive into the Ocean Zones

The ocean is a three-dimensional liquid world. It's wide and it's deep. Scientists have divided the ocean depth into five zones. These zones are based on the amount of sunlight that reaches them.



**Sunlight Zone:** This is the surface layer of the ocean. It extends from the surface down to 656 feet. Sunlight warms and provides energy to this zone of the ocean. An abundance of plants, algae and animals live here, kelp forests grow here, and polyps build coral reefs in this zone.

**Twilight Zone:** Extending from 656 feet down to 3,281 feet, only faint sunlight shines here, which makes it much cooler than the sunlight zone. A few **bioluminescent** creatures inhabit this zone.

**Midnight Zone:** This zone extends from 3,281 feet down to13,124 feet. No sunlight reaches this zone, and the water pressure reaches 5,850 pounds per square inch. In spite of the pressure, many creatures, including many more bioluminescent creatures, live here. Sperm whales even dive down to this level in search of food. Like the sperm whale, many other sea creatures move from level to level. Some creatures, even some of the largest predators, spend their days in the lower levels and then **migrate** upwards at night to search for food.

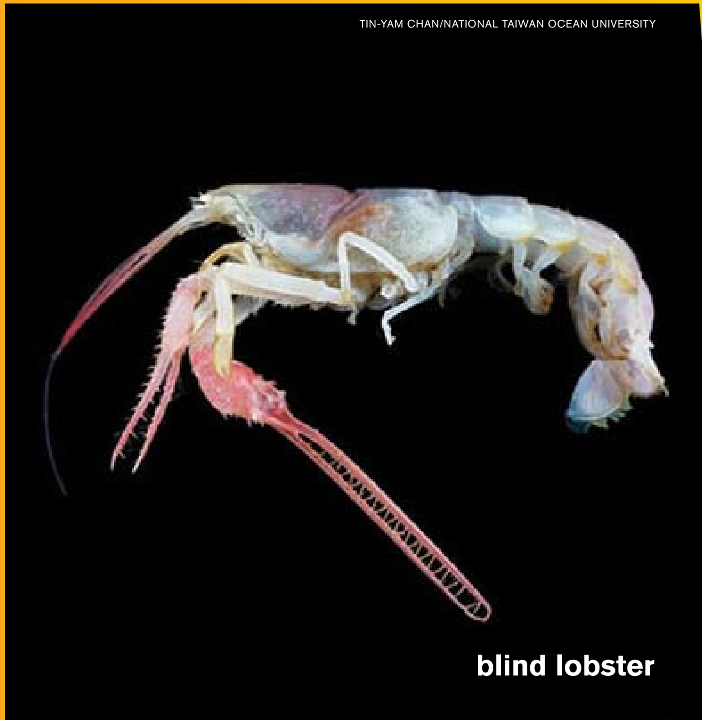
**The Abyss:** This layer extends from 13,124 feet down to 19,686 feet. Three-quarters of the ocean floor lies within this zone. The temperature is near freezing, and the pressure would crush most living things, so few creatures live here. Most are invertebrates.

**The Trenches:** This layer extends from 19,686 feet down to the bottom of the deepest parts of the ocean, 35,797 feet. The temperature of the water is just above freezing. The pressure is about eight tons per square inch. That's the same as eight humpback whales piled on top of one another for every square inch. Invertebrates such as sea stars and tube worms can thrive at these depths.

# NEW SPECIES FOUND

**For the past decade, scientists with the Census of Marine Life have been taking a census of the oceans. Along the way, they may have found as many as 5,600 new species! Many of these organisms are too small to see without a microscope, while others are much larger. And they found living things everywhere they looked. They scooped up thousands of invertebrates from 3 miles below the ocean surface. They found sea spiders the size of dinner plates and sea stars the size of manhole covers in the ocean off Antarctica. The census will end in 2010, but it will take years to study everything it uncovered.**

**For more information on the Census of Marine Life go to http://www.coml.org/**


TIN-YAM CHAN/NATIONAL TAIWAN OCEAN UNIVERSITY

**blind lobster**

Activity
Grades 3-6

# What Lives in Different Ocean Zones?

## Learning Objective

To learn about the zones in which some ocean animals live.

## Tasks

1. Divide students into groups of three or four. Tell them that they are marine biologists studying the animals that live in the different ocean zones.

2. Hand each group a copy of page 24, the diagram that shows the five zones that make up the ocean depths. Discuss the characteristics of each zone.

3. Hand each group a copy of page 27, which has line drawings of different ocean creatures. Have students cut out the creatures.

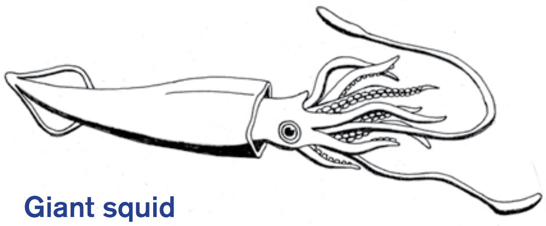
4. Invite students to research the sea creatures and glue or tape them in the correct zone. Be sure to remind students that some animals migrate between zones, and they should note this.

5. Have each group present its completed diagrams and explain why they chose the zone in which they put each creature.

6. Check to see if students placed the same creature in different zones. Have them discuss why those creatures may or may not belong in the different zones.

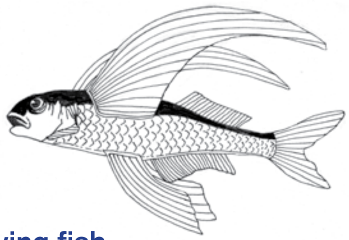


ribbon sweetlips

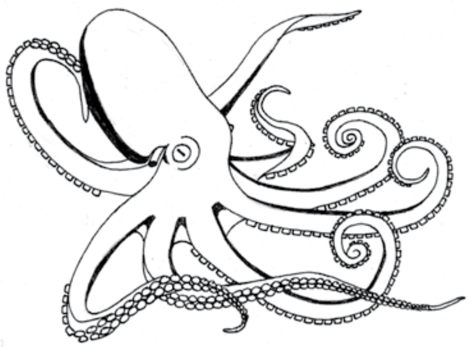


Giant squid

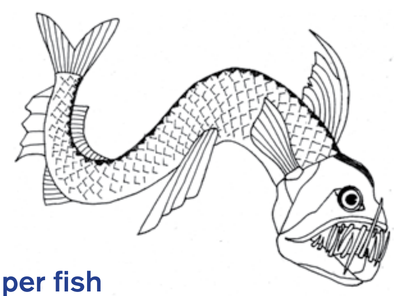
Angler fish



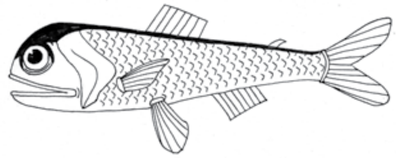
Flying fish



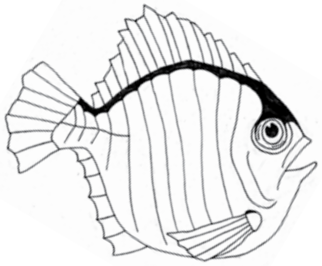
Octopus



Viper fish



Lantern fish



Hatchet fish

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# Ocean Habitats

## Kelp Forests

Kelp is an algae. Algae range in size from 100-foot-tall giant kelp to microscopic cells. Algae do not have roots, stems, leaves, or flowers.

Kelp doesn't grow from seeds. It grows from **spores.**

Giant kelp forests grow in cool, shallow waters. You can find them along the U.S. West Coast, and the costs of South America, South Africa, southern Australia, and parts of Europe and Asia.

An individual kelp is known as a thallus. It has three main parts: the holdfast, the stipe, and the blades.

The holdfast anchors kelp to the ocean floor and looks somewhat like roots, but it doesn't take in nutrients like roots do.

The stipe is like the stalk of a plant. It holds kelp upright.

The blades are leaf-like appendages that extend from the stipe. This is where photosynthesis takes place. Blades at the top of kelp form a canopy. This upper layer of a kelp forest gets the most sunlight.

Some kinds of kelp have gas bladders. These hold air and keep the plant afloat. They are located at the base of the blades, where the blades meet the stipe.

There are different kinds of kelp. Giant kelp is a **perennial** that can live for up to seven years. It can grow up to two feet a day. Bull kelp is an **annual** that lives for one year. It can grow up to 4 inches a day.

Different kinds of animals live in different layers of kelp. In one study, scientists discovered 23,000 invertebrates living in the holdfasts of just five kelp plants.

Nudibranchs can live on the floor. They are slow-moving predators, feeding off of algae, sponges, tunicates, anemones, and corals. They can take days to consume their food.

Fish swim along the floor as well as the canopy. While some fish live exclusively in kelp forests, many others visit them to swim among the stipes looking for food. These fish and other **prey** attract **marine mammals.** Harbor seals, otters, sea lions, and whales may feed in a kelp forest.

The consumers that live in kelp forests are both herbivores and carnivores. Snails, for example, feast on kelp. Most of the fish eat other animals. Sea urchins and sea otters are part of one kelp forest food chain. Sea urchins eat kelp holdfasts, trimming the kelp forest. Sea otters, in turn, eat the sea urchins, limiting the sea urchin population and bringing balance to the kelp forest ecosystem.

## BIG JOB. SMALL PLANT.

**Algae are the most abundant organisms in the oceans. One form of algae, phytoplankton, floats on the ocean surface. It produces about half the oxygen all people and animals breathe.**

Activity
Grades 2-6

# Build a Kelp Forest

**Kelp forests may be new to many students. This activity will help them learn about life in this unique habitat.**

## Learning Objective

To identify the main parts of a kelp plant and some of the animals that live in a kelp forest. Discuss a kelp forest food web.

## Tasks

1. Ask students what a kelp forest has in common with a forest that grows on land. *(A kelp forest has various layers like a forest that grows on land. It also provides a habitat for many other creatures.)*

2. Explain to students that they will make a model of a kelp plant. Divide students into groups of three or four and hand each group a 10-foot by 30-inch sheet of brown rolled paper or butcher paper.

3. Explain that students will make a scale model of a kelp plant, which can grow to be 100 feet tall. Direct each group to draw a giant kelp plant on their paper, making sure they use the whole length.

4. After students have finished drawing the kelp plants, ask them to label the holdfast, stipe and blades.

5. Hang each group's paper on the wall to give students an idea of how tall kelp is. Remind them that kelp can grow up to ten times taller than their drawings.

6. Give students more brown paper and ask them to draw blades that can be used to form the canopy. Explain that the canopy is the uppermost layer of a kelp forest. Hang the canopy on the ceiling above the stipes.

7. Have student-groups research various animals that live in a kelp forest. After students finish their research, direct them to draw and color in some of the creatures. Have younger students draw the animals to relative size, making sure bigger animals, such as whales, are larger than smaller animals, such as shrimp. Have older students draw the animals to the same scale as the kelp plant—1/10 the size of the real creatures.

8. Remind students that different sea creatures live in different areas of a kelp forest. Have them glue the creatures to the paper strips, placing them either near the holdfast, stipes or blades.

### Extension Activity (Grades 4-6)

Have students look at the kelp forest. Ask them to use what they have learned about the plants and animals in a kelp forest to draw a food chain. The food chain should start with the sun and include at least two consumers. Ask students: What a food chain is. *(A food chain is how energy is transferred in a habitat.)*

### Extension Activity 2 (Grades 2-6)

Direct students to make a scale model of a land forest. They could choose the kind of forest that is grown in the area in which they live, or forests that grow in other areas. Hang the trees on another wall and post scale drawings of the plants and animals that live in the forest. Have students discuss the similarities and differences between the kelp forest and land forest. You might draw a Venn diagram on the board to help students as they discuss the two kinds of forests.

**Good teacher resources for this activity:**

National Geographic Magazine: "Undersea World of a Kelp Forest" by Sylvia Earle

"Forests of the Deep" Video from National Geographic TV (1999)

Monterey Bay Aquarium Kelp Activities: http://www.montereybayaquarium.org/efc/efc_kelp/kelp_resources.aspx

Windows on the Wild: Biodiversity, by Judy Braus

Bill Nye The Science Guy—Ocean Life DVD: http://www.dep-store.com/product-p/77a43vl00.htm

More information on kelp from UC Berkeley: http://www.ucmp.berkeley.edu/chromista/phaeophyta.html

Ocean-related books, DVDs, activities, and games that could be good extension resources: http://www.acornnaturalists.com


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## Coral Reefs

More creatures may live in coral reefs than any other habitat on Earth. Coral reefs cover less than one percent of the ocean floor, but support about 25 percent of all sea creatures.

Most tropical coral reefs are found in warm waters near the Equator.

The Great Barrier Reef, located off the coast of Australia, is the largest coral reef. It is about 2,000 kilometers long and can be seen from space.

Despite its large size, the Great Barrier Reef may not house the greatest diversity of coral reef fish. That distinction belongs to the reefs off of Indonesia. More than 1,650 fish species swim through the reefs off of eastern Indonesia alone.

Tiny organisms called coral polyps build coral reefs. These **invertebrates,** animals that don't have backbones, have soft bodies and are related to jellyfish and sea anemones.

Polyps build skeletons made of calcium around themselves. When these hard outer skeletons touch, they begin to build a structure called a coral head. The accumulation of coral heads over time can become a coral reef. This process can take thousands of years. Some of today's coral reefs started growing 50 million years ago.

Coral reefs are known for their bright colors, but polyps are actually translucent. Reefs get their magnificent colors from algae that live in each polyp's body. The algae does more than give coral its color, it also provides food for the polyps.

Polyps cannot get all the food they need from algae. They also have barbed, toxic tentacles that grab **zooplankton,** or free-floating, microscopic animals, and even some small fish.

From big to small, all the animals in a coral reef try to find food. They are all part of the food web. Each kind of animal has a different way of getting food.

The stonefish, for example, uses camouflage to trick prey. Its brownish color makes it look like just another rock at the bottom of a reef, so that unsuspecting prey can't see the fish hiding. When the prey swims by, however, the stonefish ambushes it unsuspectingly.

In its search for food, one tiny crab has a big job. It cleans the coral reef. Trapeziid crabs are only about a third of an inch long, yet these crabs clean sediment off the reefs. Sediments can build up and actually damage the coral.

This is a good example of a **symbiotic relationship.** It is a relationship where at least one of the species involved is always helped. In this case, both animals involved benefit: the coral provides a home for the crabs and the crabs clean the coral.

Another example is the symbiotic relationship between zooxanthellae, an algae, and coral polyps. Through photosynthesis, the zooxanthellae produce oxygen that the coral polyps need to make food and calcium carbonate to build reefs. In return, the polyps give zooxanthellae a safe place to live and chemicals they need for photosynthesis. Without this symbiotic relationship, coral reefs wouldn't exist.

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Trapeziid crabs and coral polyps are not the only reef creatures with symbiotic relationships. One kind of hermit crab carries a sea anemone on its back. The anemone protects the crab with its thrashing tentacles and gobbles up the crab's leftovers.

The clownfish and sea anemone also help each other survive. The sea anemone has toxic tentacles that sting most fish. But not the clownfish. It is covered with a special slime, which protects it from the tentacles. The anemone protects the clownfish from hungry **predators,** while the clownfish feeds on undigested matter which could otherwise potentially harm the sea anemone. In addition, the fecal matter from the clownfish provides nutrients to the sea anemone. It has also been suggested that the activity of the clownfish results in greater water circulation around the sea anemone. This causes an anemone's tentacles to wave.

Symbiotic relationships are **adaptations.** An adaptation is a physical trait, body part, or a behavior that allows a plant or animal to survive in its habitat.

Color is another adaptation. For instance, the spiny devilfish is usually brown. But when the devilfish senses danger, it flashes its brightly colored orange pectoral fins to warn predators. These pectoral fins are a warning that the devilfish is poisonous, encouraging predators to stay away. As a result, predators know better than to try and make a meal out of the spiny devilfish.

The broadclub cuttlefish has another colorful trick. When it spots prey, it puts on a colorful light show by flashing blue, red, and yellow. Its prey is mesmerized or confused by these changing colors, giving the cuttlefish time to strike. Like cuttlefish, octopuses and squid can change color. They also have another kind of adaptation—intelligence. They are the most intellectually advanced invertebrates. These animals can solve simple problems and remember the solutions.

While coral polyps provide a habitat for many organisms by building reefs from the ocean floor to near the surface of the ocean, those reefs are also being worn away. Waves erode, or destroy, the coral by cutting deep furrows into the reefs.

Some of the animals that are found in a reef can also cause destruction. Parrotfish, for example, actually attack coral reefs. The parrotfish bites into the coral skeleton, digesting it. After digesting, the fish expels the skeleton in the form of white sand. This sand may help form some beaches.

Numerous species of worms, algae, gastropods, sponges, and other invertebrates attack the coral structure from underneath. These animals can burrow into the coral, producing cavities and canals, thereby weakening the structure. However, these crevices become important homes for many other animals in the coral reef, creating a balanced ecosystem.

## LOOKING FOR A HOME?

**New research shows that zooxanthellae may have eyes. This single-celled algae has light-sensitive eyespots and crystals that reflect light. Combined, the crystals and eyespots indicate fully functional eyes. The algae may use its eyes to find the best coral polyp in which to settle. It loses its ability to see after it begins living inside its host.**

# REEFS IN PERIL

Coral reefs may be one of Earth's most colorful and abundant habitats, but many face destruction. Overfishing and mining of coral and sand are serious problems that upset a reef's food web and can even destroy the reef itself.

Carbon dioxide ($CO_2$) is an even larger threat. It's one of the gases that cause global climate change. Climate change is increasing ocean water temperature near the surface. This is killing the algae that allow polyps to survive. Because the algae give coral its characteristic color, affected reefs turn white, which is called bleaching.

Carbon dioxide in air can mix with sea water, forming carbonic acid.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

Carbonic acid affects a coral polyp's ability to make its calcareous skeleton, so many reefs are not growing as fast as they used to. If acidification, the concentration of carbonic acid, continues to increase, polyps may no longer be able to make reefs at all.

<u>How You Can Help</u>

One simple action you can take to reduce $CO_2$ emissions, which can damage reef systems, is to carpool, ride your bike, or walk to school.

Activity
Grades 2-6

# Coral Reef Color

**Living things have many adaptations. Color is just one of these amazing adaptations.**

## Learning Objective

To learn how different animals use camouflage and color. To learn about adaptations.

## Tasks

1. Explain to students that many animals use camouflage to help them survive. Some predators use camouflage to get prey. Some prey use camouflage to hide from predators. Divide students into groups of three or four. Have each group find photos on the Internet or cut out photos from magazines that show predators and prey using camouflage. Next have students look for camouflaged animals that live in a coral reef. Ask them to explain how each animal uses camouflage.

2. Have students research and draw ocean animals that are predators, prey, and animals that are both predators and prey. Have students look to see if they can find any similarities between the animals in each group.

3. Explain to students that some animals don't use color to hide. They use color to stand out. Many venomous animals are colorful, and their bright colors tell predators to stay away. Provide books and magazines and have students draw colorful, venomous coral reef animals. Ask them to explain how each animal uses its color.

4. Note that because coral is so colorful, not all colorful coral reef animals are venomous. Ask students if any animals use color for other reasons, such as to find a mate.

5. Divide the class into groups of three or four. Give each group several photos of the coral reef animals they found on the Internet or cut out of magazines. Explain that an animal's color is an adaptation. Remind your students that an adaptation can be a physical trait, body part, or behavior that allows a plant or animal to survive in its habitat. Ask them to list other adaptations they can find in the photos.

6. Using the same groups, hand each group a couple of pieces of poster board. Direct students to draw different kinds of coral on the boards. After students finish coloring their coral, have them cut out the coral and paste it on a wall in the room to form a coral reef. Have them cut out the coral reef animals from the magazine photos and attach them to the wall. Ask students to explain what is happening in the coral reef diorama they constructed.

7. Have students take some of the coral reef animals and tape them into the kelp forest model. Ask students if the animals would survive in the kelp forest, and why or why not.

**Good teacher resources for this activity:**

Oceans of Life, Educator's Guide by World Wildlife Fund: http://www.acornnaturalists.com

Treasures in the Sea: Bahamian Marine Resources (an Educator's Guide to Teaching Marine Biodiversity). Bahamas National Trust and American Museum of Natural History. 2007.

Coral Reefs Activity Guide from Shedd Aquarium: http://www.sheddaquarium.org/pdf/education/edu_guide_coral-reefs.pdf

Coral Reefs: http://ngsp.com

Ocean Animals: http://ngsp.com

Activity
Grades 2-6

# What Do Oceanographers Do?

## Learning Objective

To learn how many scientists from different disciplines work together to gain a more complete understanding of the oceans.

## Tasks

1. Divide students into four groups. Have the students in each group imagine that they are different kinds of scientists who study the oceans.

2. Explain that many oceanographers, scientists who study the oceans, have one of four main areas of expertise. (1) Marine biologists study the algae, animals, and plants that live in the oceans. (2) Marine geologists study the ocean floor and how it formed. (3) Chemical oceanographers study the chemicals that make up seawater. (4) Physical oceanographers study the physical characteristics of seawater, such as temperature, tides, and the movement of currents.

3. Tell the students in each group to imagine that they are oceanographers who specialize in one of the four main areas and assign each group its specialty.

4. Tell students that the largest coral reef in the world, the Great Barrier Reef, is in trouble. Tourism, global warming, and acidification are all affecting the reef.

5. Have each group research the Great Barrier Reef and then develop a plan that explains how they can use their expertise to better understand what is happening there.

6. Ask each group to present its plan to the class.

7. Have the class discuss how all the oceanographers working together could lead to a better understanding of what is happening in the Great Barrier Reef.

### Extension Activity

You can repeat this activity by assigning different ocean habitats or by having students in each group imagine that each of them is from




Humpback whale

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## The Open Ocean

Many of the animals that live in the open ocean migrate—they move from one place to another. Some animals migrate from one area of the ocean to another over a long span of time; others migrate up and down the water column daily. Sailfish, mackerel, whales, sharks and manta rays travel thousands of miles to find feeding and breeding areas. Deepwater animals like lanternfish and Humboldt squid spend the day in deep water, but travel upwards at night in search of food.

The open ocean is the domain of the blue whale, the largest animal ever known to exist. Despite their large size, these marine mammals eat mostly krill, tiny shrimp-like invertebrates.

The humpback migrates through the open ocean between its feeding and breeding grounds. Each year, it may travel about 6,000 miles. North Pacific humpbacks spend part of the year in the nutrient-rich water of the Gulf of Alaska. In early autumn, they head to more tropical waters to breed.

The sperm whale has the largest brain of any animal. Its head can take up one third of its enormous length. It is the largest predator and may even hunt the mysterious giant squid. It has 20 to 26 teeth. No one knows how it uses these teeth, because it doesn't need them for eating squid.

© MARK DOHERTY/SHUTTERSTOCK


Indian mackerel

## The Deep Sea

The average depth of the ocean is about 2.5 miles below sea level.

Many parts of the ocean are much deeper. The Mariana Trench, for example, is nearly seven miles below the surface.

The deepest parts of the ocean are cold and dark. Sunlight never reaches here. Temperatures are only about a few degrees above freezing.

Some of the animals that live this deep, such as the giant isopod, have no eyes. Without sunlight, some animals have lost the ability to see, and have instead found other ways to sense their surrounding environment.

Some of the animals that live in the deep actually glow. This is called bioluminescence. In some cases, the animals have chemicals in their bodies that cause them to glow. In other cases, they carry bacteria that glow.

Other animals have giant eyes. The giant squid's dinner plate-sized eyes allow it to see the dim outlines, or bioluminescence, of other deep-sea creatures.

One excellent example of bioluminescence is displayed in the viperfish. The viperfish has nearly 350 tiny lights. It uses these lights to lure prey towards its mouth, which is lined with needle-like teeth that are so long it cannot completely close its mouth.

Another example of bioluminescence can be observed in the dragonfish and the anglerfish. Each of these creatures has what looks like a fishing pole on the tip of its nose. Bacteria that live on the end of the "pole" make light that lures in fish. Ultimately, these fish find themselves caught in a set of terrible jaws.

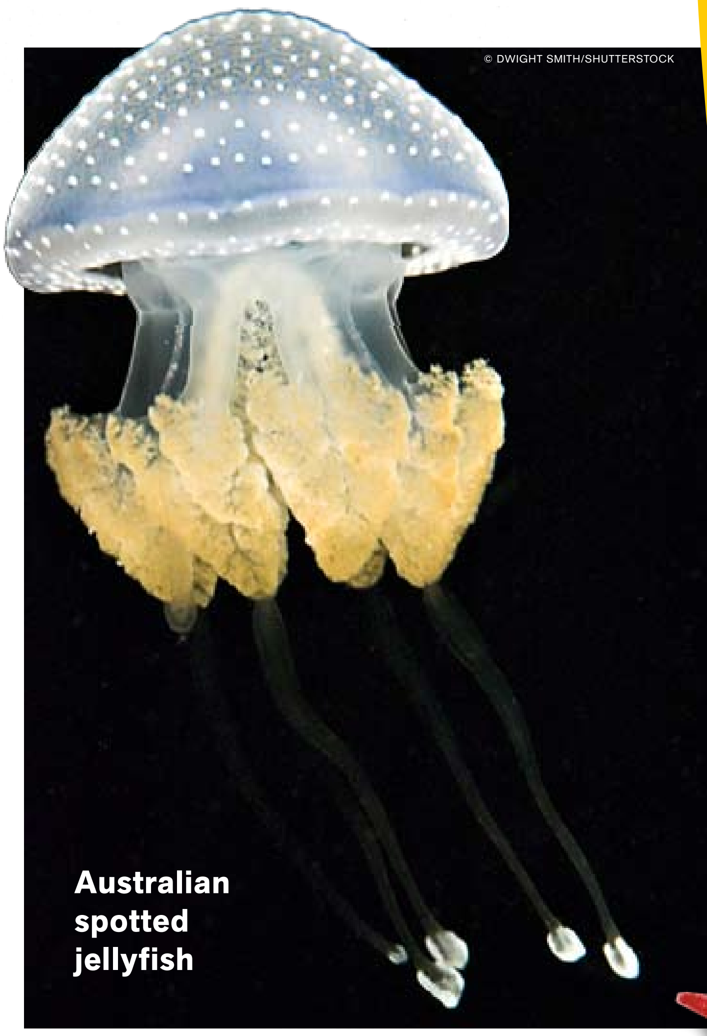
Some creatures use bioluminescence to hide from other creatures. Light-producing organs on the sides of hatchetfish and lanternfish make them invisible to predators viewing them against the lighted waters above them.

Other deep-sea species use distinctive light patterns to identify one another.

But it's not just predators that use bioluminescence to their advantage. Prey, such as plankton, can use bioluminescence to confuse predators. Dinoflagellates, the most common source of bioluminescence in the oceans, can use their ability to glow as a sort of "burglar alarm." When a dinoflagellate is disturbed, its cell shape changes, triggering luminescence. This flash of light can attract larger predators that eat the predators of the dinoflagellate! Certain types of zooplankton, known as copepods, have even been documented to shoot bioluminescent excretions to confuse predators.

Not all bioluminescent creatures live in the deep. For example, some fish that hunt at night are bioluminescent. The flashlight fish has bacteria under each eye that glows in the dark. The light attracts prey.

Because bioluminescence is so abundant in the oceans, scientists believe that light communication is actually the number one form of communication on Earth.





**Australian spotted jellyfish**

Activity
Grades 4-6

# Glowing in the Dark

## Learning Objective

To conduct an experiment that shows how some fish use bioluminescence to survive.

## Tasks

1. Divide the class into small groups. Tell students that they are marine biologists working with National Geographic. They need to learn why some fish glow, or are bioluminescent.

2. Hand each group a shoe box. Have them paint the inside of the box black, or line it with black paper.

3. Use a pair of scissors to cut an eyehole into the middle of one of the box's short sides. Some students may need help with steps 3-6.

4. Use a thick pin or needle to randomly pierce holes into the other short side. Explain that the pinholes are bioluminescent spots.

5. Have students fold a black sheet of paper in half and draw a fish on one half. Have them cut out the fish so that they have two of them.

6. Using the same pin, poke holes into one of the fish. Younger children may need help with this step. Tell students that the pinholes represent bioluminescent spots on the fish.

7. Tape a thin strip of black paper to each fish. This will be used to hang the fish from the cover of the shoe box.

8. Tape the strip of the fish without pinholes to the middle of the cover and place the cover on the shoe box so the fish hangs down.

9. Before students look through the eyehole, have them predict what they will see when they look at each fish through the box. Ask them to write down their predictions.

10. Direct students to hold the box up and point it toward a window or light. Then have them look through the eyehole and record their observations.

11. Have them repeat and record the observation using the fish with the pinholes.

12. Ask students to discuss their predictions and then check them as a class. Ask which fish was easier to see. *(The fish that didn't have pinholes was easier to see. It didn't blend in with the pinhole background. Predators would have an easier time finding it.)*

### Extension Activity

Divide students into groups of three or four. Have them imagine they are marine biologists who want to understand how sea creatures might use bioluminescence to communicate. Hand each group a flashlight. Ask them to develop a simple code for the following messages using long and short flashes as well as movement. Students can also develop their own messages. When students are ready, turn off the overhead lights and have a member of each group send the messages to another member. See if the receiver understands the messages.

Here are some possible messages:

1. A friendly greeting.
2. An announcement that you found prey.
3. A warning that a predator is nearby.
4. A signal that lures prey to come closer.
5. A warning signal that you are too dangerous for a predator to attack.

### Good teacher resources for this activity:

National Geographic Bioluminescence Lesson Plans: http://www.nationalgeographic.com/xpeditions/lessons/08/g68/seasbiolum.html

Fun page for kids on bioluminescence: http://www.seasky.org/deep-sea/biolumiscence.html

Information on bioluminescence from UC Santa Barbara: http://www.lifesci.ucsb.edu/~biolum/

## Hydrothermal Vents

Hydrothermal vents are among the hottest places on Earth. Located on the sea floor, these vents are created by volcanic activity under Earth's crust. They are like underwater geysers.

Water flows through cracks in the sea floor where it is heated by magma. The water can reach 750 degrees Fahrenheit. The superhot water rapidly rises and gushes out of vents.

The superheated water dissolves minerals as it rises through a vent, carrying the minerals with it. These vents are largely responsible for depositing minerals in the oceans and for the chemical makeup of the oceans.

These vents are found in many places, from the Arctic ocean to the mid-ocean ridge.

Most hydrothermal vents are fairly small. But some are megaplumes, hydrothermal **plumes** ten to twenty times larger than ordinary plumes. Heat from the vents shoots water high above the ocean floor. In some cases, the vents can fire water nearly 5,000 feet above the seafloor.

Minerals emitted by the vents can cool rapidly and form immense chimneys. These can stretch nearly 200 feet above the sea floor. Some grow at the rate of a foot a day!

Most land-based creatures could not survive near these vents. The heat would be unbearable. Also, hydrogen sulfide, one of the chemicals given off by the vents, would kill most creatures.

Yet these vents are hotbeds of activity for certain life forms. In fact, scientists have found more than 300 species living around these hydrothermal vents.

Microbes that flourish in hydrogen sulfide have long been known to live around these vents, where hydrogen sulfide and microbes are the foundation of the food web.

Scientists have discovered tube worms that live near the vents. These tube worms are hosts to microbes, or bacteria, that live inside them in a symbiotic relationship. The tube worms have red plumes that contain hemoglobin. This hemoglobin combines with hydrogen sulfide and transfers it to the microbes. The microbes, in turn, nourish the worm with carbon compounds, allowing the tube worms to thrive in an extremely harsh environment.

Scientists are finding undiscovered hydrothermal vents throughout the oceans. They're also discovering previously unknown species near these vents. In 2007, scientists discovered a special kind of vent in the Pacific Ocean off the coast of Costa Rica. These are known as black smoker vents because of the dark, mineral-rich water that flows from them. Scientists found pink jellyfish shaped like bells around these vents. They had never seen jellyfish that color before.

Black smokers make a slow rumbling sound as water erupts. Water can shoot out at 300 gallons per minute. That's enough to fill a bathtub in a few seconds!

Activity
Grades 4-6

# Food Chains

## Learning Objective

To learn that living organisms transfer energy through food chains and to understand that food chains linked together form a food web.

## Tasks

1. Arrange students in groups of three or four.
2. Place pictures of food chain components (animals; plants; plankton, tiny animals and plant-like organisms that float freely in the water and can only be seen under a microscope; krill, small shrimp-like creatures that live in all the oceans; chemicals from hydrothermal vents; and sunlight) on one or more tables.
3. Then have each group use the pictures to create an appropriate ocean food chain.
4. Once each group is done, ask the students to share their food chains with the class.
5. Have the students group several food chains together to form an ocean food web.
6. After putting the food webs together, discuss the importance of each component in the web. Ask these questions: What would happen if one component were removed? What would happen if several were removed? Discuss student answers as a group.

**Here are some examples of food chains that begin with sunlight and some that begin with chemicals from hydrothermal vents.**

1. sunlight → plankton → brine shrimp → atlantic devil ray
2. sunlight → plankton → krill → blue whale
3. sunlight → seagrass → Florida manatee
4. sunlight → algae → marine iguana
5. sunlight → plankton → herring → brown pelican
6. sunlight → plankton → crustaceans → sea nettle jellyfish → leatherback sea turtle
7. sunlight → plankton → anchovies → Galapagos fur seal
8. sunlight → plankton → mussels → sea urchin → otter
9. sunlight → plankton → crustaceans → octopus → white tip reef shark
10. sunlight → plankton → krill → snort-snouted spinner dolphin
11. chemicals from vents → bacteria → giant tube worms
12. chemicals from vents → bacteria → vent clam → blind crabs
13. chemicals from vents → bacteria → vent shrimp → zoarcid fish → vent octopus

**Good teacher resources for this activity:**

Information on chemosynthetic food webs:
http://www.montereyinstitute.org/noaa/lesson05/l5la1.htm

# More resources about Earth's oceans can be found on the following websites.

- NOAA information on Hydrothermal vents: http://www.montereyinstitute.org/noaa/lesson05.html
- NOVA Online: Into the Abyss: Living at Extremes: http://www.pbs.org/wgbh/nova/abyss/life/extremes.html
- Smithsonian's Ocean Planet: Creatures of the Thermal Vents: http://seawifs.gsfc.nasa.gov/OCEANPLANET/HTML/ps_vents.html
- Kids portal from the U.S. Government featuring information on corals, weather, national marine sanctuaries, and access to NOAA's online photo archives: http://www.kids.gov/6_8/6_8_science_oceanography.shtml
- Office of Naval Research: information on ocean regions: http://www.onr.navy.mil/Focus/ocean/regions oceanfloor2.htm
- Office of Naval Research: Teacher's Corner: http://www.onr.navy.mil/Focus/teachers/default.htm
- Woods Hole Oceanographic Institution's Dive and Discover page: http://www.divediscover.whoi.edu/teachers-activities.html
- SeaGrant/NOAA Bridge Page (free teacher-approved marine educational resources): http://web.vims.edu/bridge/?svr=www
- Disney Worldwide Conservation Fund: information on how Disney helps oceans www.disney.com/conservation
- The Nature Conservancy: http://www.nature.org
- Conservation International: www.conservation.org
- NOAA: www.nmfs.noaa.gov
- Save Nature: www.savenature.org
- National Marine Sanctuary Foundation: www.nmsfocean.org
- International Fund for Animal Welfare (IFAW): www.ifaw.org
- Ocean Conservancy: http://www.oceanconservancy.org/site/PageServer?pagename=home

# Glossary

**adaptation:** a physical trait, body part, or behavior that allows a plant or animal to survive in its habitat

**annual:** algae or plant that lives for one growing season

**bioluminescence:** the ability of a living thing to use chemicals inside its body to make light

**carnivore:** a consumer that eats animals

**chemosynthesis:** a process in which a producer uses chemicals to make energy

**consumer:** a living thing that does not make its own food, but instead eats other organisms

**continental shelf:** the part of Earth's crust that slopes away from continents and into the ocean, towards the continental slope

**continental slope:** the sudden drop in Earth's crust that dips down to the deepest parts of the ocean floor and connects the continental shelf with the oceanic crust

**crust:** the uppermost layer of Earth

**decomposer:** an organism that gets its energy from eating dead or decaying matter

**Equator:** the imaginary line that extends around the middle of Earth and divides the Northern Hemisphere from the Southern Hemisphere. This is where tropical environments occur.

**food chain:** part of a food web; how energy moves from one living thing to another

**food web:** the way different food chains overlap in which energy is transferred between many different living things

**gyre:** a circular system of ocean currents that moves clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere

**habitat:** the place where a plant or animal lives and can find all of the things it needs to survive

**herbivore:** a consumer that eats only plants

**invertebrate:** an animal without a backbone

**island:** a small landmass surrounded by water

**lava:** molten rock on Earth's surface

**magma:** molten rock inside Earth

**marine mammal:** mammal that lives in the oceans

**mid-ocean ridge:** the mountains and volcanoes that rise up in the middle of an ocean

**migrate:** to move seasonally or periodically from one place to another and back to the first place for food, shelter, or reproduction

**mountain:** tall peak that rises above the surrounding land

**ocean current:** river of water that moves through the ocean

**ocean plain:** flat area of Earth's surface

**omnivore:** a consumer that eats both plants and animals

**perennial:** algae or plant that has a life cycle lasting at least two years

**photosynthesis:** process that producers use to convert sunlight into food

**phytoplankton:** free-floating photosynthetic algae that make up the base of most ocean food webs (primary producers in the ocean)

**plate:** a large section of Earth's upper crust and mantle

**plume:** column of one fluid moving through another

**predator:** animal that preys on other animals

**prey:** an animal a predator eats

**producer:** an organism that is able to make its own food

**ridge:** chain of hills or mountains

**spore:** reproductive structure able to survive unfavorable conditions and capable of development into a new individual

**subduction zone:** area where one plate moves under another plate

**symbiotic relationship:** two or more plants and animals depend on each other—help one animal and not affect the other animal (commensal), help both animals (mutual), or help one and hurt the other (parasitic)

**trench:** a long, narrow canyon that comprises the deepest spots of the ocean floor

**volcano:** a weak spot or opening in Earth's crust through which lava, steam and ashes can erupt

**zooplankton:** free-floating, microscopic animals that feed on phytoplankton or other zooplankton (primary consumers)

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**Experience the stories that connect their world to ours.**

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# oceans

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