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ABSTRACT

The Ocean Planet is a traveling exhibition from the Smithsonian Institution designed to share with the public what recent research has revealed about the oceans and to encourage ocean conservation. This booklet of lessons and activities adapts several themes from the exhibition for use in middle and high school classrooms. Lesson plans include: (1) "Sea Secrets" that explores ocean geography; (2) "Sea Connections" that looks at plants and animals that live in different marine ecosystems; (3) "Pollution Solution" that examines the effects of an environmental crisis; (4) "Stranded Along the Coast" that explores both natural and human causes of animal strandings; and (5) "Reflections on the Sea" that explores the influence of oceans on language and literature. Each lesson plan contains background information, a statement of learning objectives, a list of required materials, step-by-step procedures, student handouts, and a list of educational resources including connections to the online version of the Ocean Planet exhibition. (JRH)

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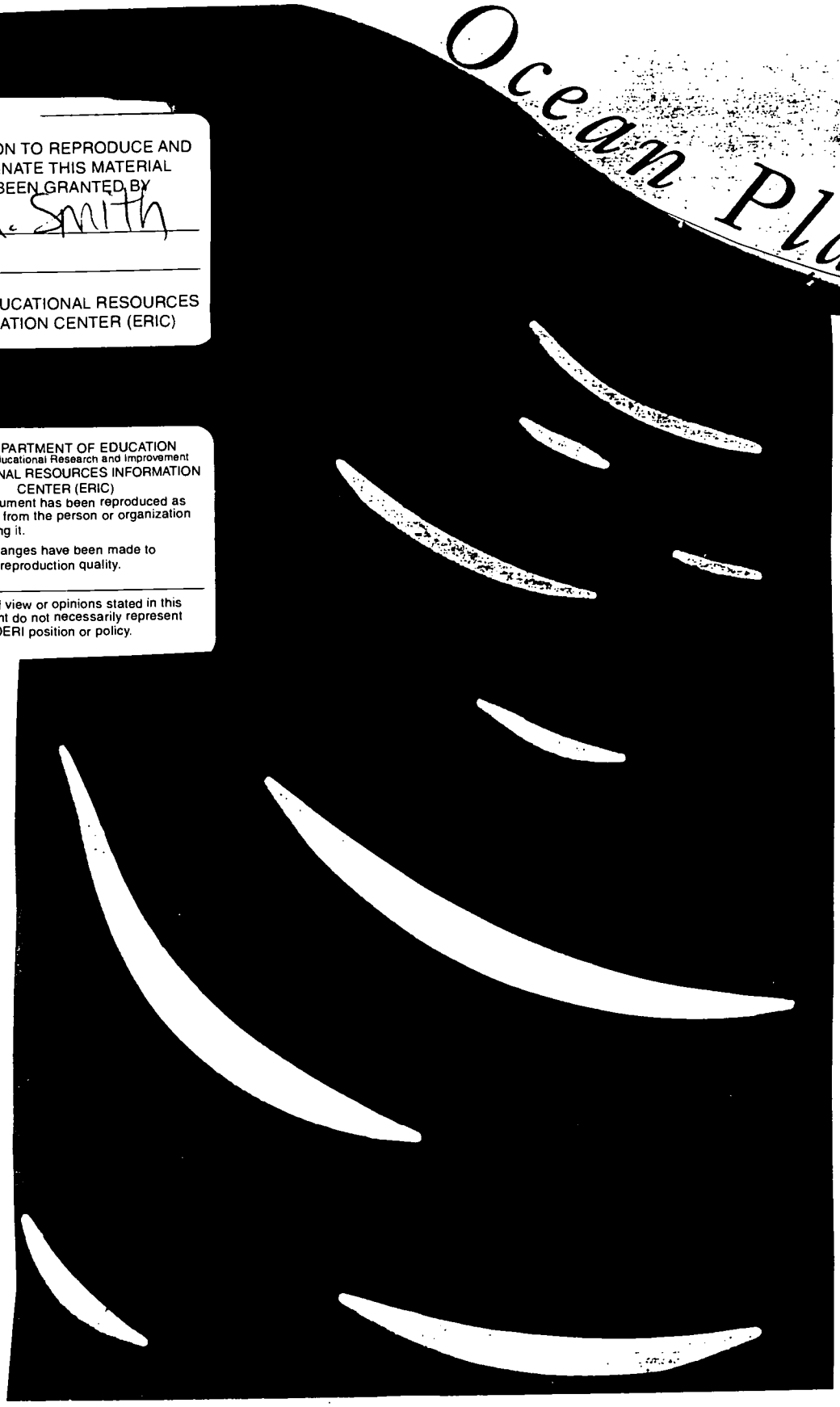
Ocean Planet



Ocean Planet

Interdisciplinary Marine Science Activities

Smithsonian Institution

Office of Elementary and Secondary Education

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brother.

fter centuries of seafaring, we're only now beginning to plumb the workings of our watery planet. The deeper we go, the clearer it becomes that no matter who we are or where we live, we all have a hand—and a stake—in what happens in the seas. he Smithsonian Institution created the exhibition *Ocean Planet* to share with the public what recent research has revealed about the oceans and to encourage ocean conservation. This booklet of lessons and activities adapts several themes of the exhibition for use in the middle and high school classroom. *cean Planet* has six lesson plans. "Sea Secrets" explores ocean geography; "Sea Connections" looks at the plants and animals that live in different marine ecosystems. "Ocean Market" identifies and values many products of the seas. "Pollution Solution" examines the effects of an environmental crisis. "Stranded Along the Coast" explores both natural and human causes of animal strandings. Finally, "Reflections on the Sea" explores the influence of oceans on language and literature. ach of the the six lesson plans has the same elements: background information; statement of learning objectives; list of required materials; step-by-step procedures; student handouts; and a list of additional resources, including connections to the online version of the *Ocean Planet* exhibition. he instructional approaches in *Ocean Planet* are interdisciplinary. Lesson plans will work in different classes, from biology and mathematics to geography and social studies. Many activities employ students' writing skills. e hope that the lessons in this booklet may guide students to better understand the diversity and importance of the seas.

Ocean Planet

Interdisciplinary Marine Science Activities

The traveling exhibition

Ocean Planet, a traveling exhibition from the Smithsonian Institution promoting the celebration, understanding, and conservation of the world's oceans, premiered at the National Museum of Natural History in April 1995. The exhibition marks the culmination of a four-year study of environmental issues that affect the health of the world's oceans.

The Smithsonian Institution Traveling Exhibition Service has scheduled the exhibition to tour through the U.S. cities listed here. You can also visit the online version of the exhibition at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**

Bishop Museum,
Honolulu, Hawaii:
May 17, 1997–October 5, 1997

Chicago Museum of
Science and Industry:
May 23–August 15, 1998

Museum of Science, Boston:
September 19–December 13, 1998

or centuries, people have been challenged by the mysteries that lie beneath the blue depths of our ocean planet. Very little was known about the ocean until late in the nineteenth century, although nearly three-quarters of the planet is covered by ocean or seawater. Myths and misconceptions abounded. We used to think that the ocean depths were devoid of life. We thought that the seafloor was flat and that it was the same age as the continents. How different a picture we now have of the ocean as the sea has begun to yield its secrets. n the 1870s, the HMS *Challenger* left England and sailed the world's oceans, throwing out weighted lines and taking soundings to measure the depths of the Atlantic, Pacific, Indian, and Arctic Oceans. For the first time, scientists had an inkling of the contours of the ocean floor, took samples of the plants and animals, and measured differences in water temperature and salinity. But the cold, dark water and extreme pressure of the depths kept scientists from knowing the secrets of the deep abyss. ollowing in the footsteps of those pioneering oceanographers, today's scientists have overcome many of the challenges of the deep by using more sophisticated tools. They can send manned submersibles and sampling devices to plumb the ocean depths, taking photographs and samples of animal life and sediment to bring back to the surface for further study. Even space technology enters the picture. Satellite photos taken of the ocean provide a wide range of information, including water temperature and depth, seafloor topography, and the plankton populations. Using sonar and satellite data, scientists have been able to generate a new map of the ocean floor, thirty times more accurate than the best previous map. This map shows the ruggedness of the Mid-Ocean Ridge as it bisects the Atlantic Ocean. This contrasts to the relatively flat Pacific Ocean floor, its vast expanse broken up by more than a thousand newly discovered underwater volcanoes stretching from Hawaii to the Aleutians. nd to what does this vast treasure trove of data lead?

For
scientists, there is a
broader understanding of
how the ocean basin formed
and continues to evolve. Molten
magma from Earth's interior spews
out at the mid-ocean ridges, spilling over to
either side and hardening to rocky basalt. As the crust pushes away from the ridges, it cools and thins, forming new seafloor and thus "widening" the ocean here. As this portion of the ocean floor widens, a section of the seafloor elsewhere is slowly sliding beneath the crust, becoming part of Earth's magma once again. Plate tectonics, the theory of Earth's crustal plates, thus helps explain ocean formation. ew observations also give scientists a greater understanding of the dynamic nature of Earth's water and oxygen cycles and how planetary winds affect ocean currents. Data allow scientists to hypothesize about global weather systems, earthquake and volcanic activity, and climatic trends of global consequence. Understanding the interactions of the ocean and marine life gives us an indication of the planet's health and the effects of human activity. he development of new technologies for underwater exploration has led to exciting and lucrative expeditions. Photographs of the doomed *Titanic* taken by remote cameras from a submersible craft as it probed deep in the North Atlantic captured the imagination of the world. Recently declassified information about the locations of sunken World War II vessels has attracted adventurers and investors who would like to bring up rich cargoes. The old romantic notion of diving for Spanish pieces of eight from pirate shipwrecks in the Caribbean has been replaced by the idea of using sonar and other sensors to locate sunken submarines carrying gold. But whether in pursuit of knowledge or profit, all of these activities contribute to our understanding of the ocean.

Sea Secrets Lesson Plan

Objectives

Identify some of the features of the ocean, including a continental shelf, a deep ocean plain, a trench, and a mid-ocean ridge.

Draw a profile of the ocean using data points.

Infer the conditions of some undersea locations.

Materials

Student Pages

pencil, straightedge

Optional: world map, globe

Optional: small aquarium, sand, water, salt, metal objects

Subjects

social studies, oceanography, mathematics

Procedure

1. To introduce Sea Secrets, ask students to name the highest and lowest places on Earth's crust. They may name Mt. Everest and the Grand Canyon, respectively. Tell them that the tallest mountains and deepest canyons are found in the ocean. The Hawaiian Islands would dwarf Mt. Everest. These islands are merely the tops of huge mountains that have their base on the deep floor of the Pacific. Also in the Pacific is the deepest trench on the Earth, the Mariana Trench. It measures eleven kilometers below the sea's surface—seven times the depth of the Grand Canyon. The Pacific, named by Magellan because it looked peaceful, is the largest feature on Earth. It can look tranquil sometimes; but at other times huge waves roll, typhoons blow, and tsunamis strike the coast. Spin a globe and have students observe how great an area of Earth the Pacific occupies. Spin the globe again, and have students find and name the Atlantic, Indian, and Arctic Oceans.

2. Ask students to speculate on how people have learned about the ocean. They may know that many a sailor who went out to sea on a great clipper ship never actually went into the water—many of them could not swim. They measured depth using ropes and did their best to stay out of the briny deep. Tell students how the HMS *Challenger* went out to sea in 1872, and for three years the crew mapped and charted the many mountains and valleys of the ocean floor. Today we have a "window" into the gloom of the deep sea and can map the contours using sophisticated equipment. We use sonar—sound waves that bounce off the bottom of the ocean and back up to a research ship. The longer it takes for the sound to bounce back, the deeper the ocean floor. In some ways, robotic submersibles are like spacecraft charting the unknown regions of space. We have core samplers that drill holes into the ocean bottom and bring up layers of sediment.

3. Have students imagine they are taking the *Johnson Sea Link*, a submersible research vessel, into the gloomy darkness of the abyss. By five hundred feet below the surface, it is already dark on the sunniest day. Off the coast of Florida, it might take an hour to get down to the seafloor. The incredible water pressure of a million pounds per square inch actually squeezes the thick walls of the small capsule. Creatures of fantastic shapes are viewed for the first time by human eyes as they pass through the craft's lights. Robotic arms carefully funnel gauze-like invertebrate animals into sampling containers. The animals are brought up to the surface and studied.

4. Discuss with students how mapping, photographing, and taking core samples from the ocean floor have helped scientists to conclude how the oceans formed. Earth's crust is both younger and thinner beneath the ocean than it is under the continents. That is because new ocean floor is continually forming at the mid-ocean ridges. These ridges wrap around Earth like the seams on a baseball. Coming off the sides of the ridges are "rift valleys," from which molten rock from within Earth pours out like lava from a volcano. When it cools, it forms new ocean floor. As the rock cools, magnetic particles in the lava are frozen, pointing in the direction of the North Pole. Scientists have matched these particles with periods of pole shifts in the geologic record. They have also matched the particles on both sides of the ridge, showing that they have spread apart. The discovery of these matching "magnetic stripes" in the rocks surrounding the mid-ocean ridges propelled the theory of plate tectonics into the forefront of geology.

5. One interesting connection between biology and plate tectonics involves the life cycle of green sea turtles. The fact that South American green sea turtles swim to tiny Ascension Island in the middle of the Atlantic to lay eggs may help prove the theory of plate tectonics. Some scientists hypothesize that the ancestors of these animals made this journey before the continents were so far apart. The turtles have continued this behavior over many generations as the distance across the Atlantic has gradually increased by several centimeters each year.

6. Tell students that the deep, flat portions of the ocean floor are referred to as the abyss or the abyssal plain. Trenches occur where one of Earth's crustal plates is sliding under another. The continental slope is the area of ascent that leads to the continental shelf, the underwater edge of a continent.

7. Hand out the student pages. Have students examine the map of the Atlantic Ocean. Explain that it shows what the ocean would look like if all the water were removed. Compare the area of the map to a wall map of the world, then have students find the labeled continental shelves, abyssal plains, continental slopes, trenches, and ridges. Parts of the Atlantic trenches are more than eight kilometers deep. To make that distance more meaningful to students, use the distance between two familiar landmarks in your area (eight kilometers equal five miles). Or have them figure out how many school buses (each about ten meters long) would have to line up to cover a distance of eight thousand meters (eight hundred). Tell them that parts of the Atlantic Ocean are that deep from the surface down to the ocean floor.

8. When students seem ready to work on their own, have them plot the data points to draw an ocean profile between Florida and Dakar, Senegal. (These data are approximate and have been simplified somewhat.) Make sure students understand that a profile is a side view of the ocean floor if you made the journey along a straight line between two locations.

9. Tell students that this treasure hunt for the location of gold is based on real salvage efforts to bring up the cargo of a World War II Japanese submarine torpedoed en route to Europe with supplies of precious metals. It takes the work of people of many nations to accomplish such a task. This activity raises the issue of respect for the dead who were lost with the vessel as well as more temporal and legal disputes about who owns bounty that lies in international waters. Tell students that a nation has legal rights to waters two hundred miles off its coast. At one time countries claimed a mere three miles because that was as far as a cannonball could reach. Later, the limit was extended to twelve miles, then two hundred.

10. When students finish their profiles, have them answer the questions on the student page. They will find that the Nares Deep and Cape Verde Basins are the deepest areas in this section of the ocean and that they are separated by the Mid-Atlantic Ridge. The sunken sub is located at data point 11 at a depth of five and a half kilometers. To work on such a project, they would likely operate from the Cape Verde Islands, the closest landmass. They would probably choose to use a remotely operated vehicle because of the great depth and risk. Perhaps they would choose to erect a memorial to those who died in the sub. Gold survives well under adverse conditions because it does not react easily with other compounds and thus does not corrode like other metals or deteriorate like organic materials.

11. Challenge students to make a model ocean profile using a small aquarium, sand, and water. They can make their own seawater by dissolving thirty-five grams of salt for every liter of water. They might bury a metallic object at a specific location and challenge other students to find it without disturbing other parts of the ocean floor.

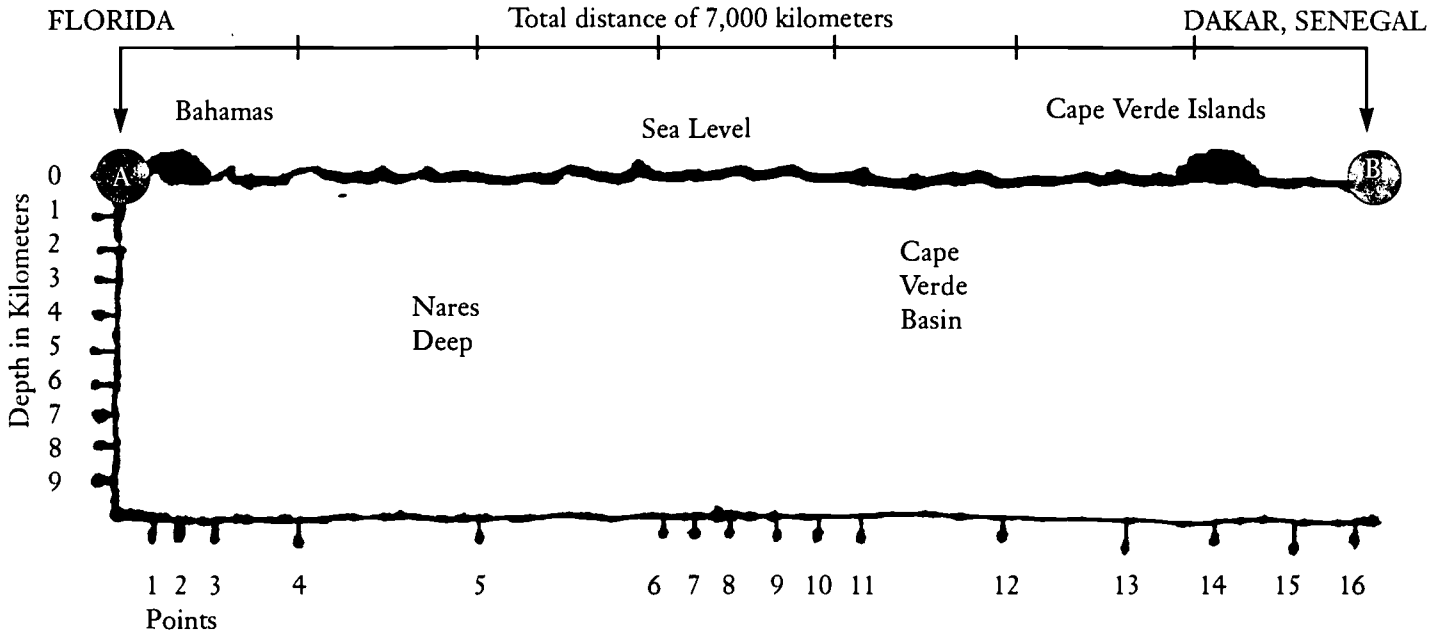
Sea Secrets Student Page

How does the sea reveal its secrets? What does the ocean floor look like? Scientists have a rough idea based on depth soundings and satellite pictures from space. The picture of the Atlantic Ocean that you see here is what the seafloor would look like if somebody could "pull the plug" and drain the water. The Atlantic Ocean floor is very rugged, with as many ups and downs as there are on land.

Find the Sunken Sub

Student Page

Find points A and B on the map—one in Florida and one in Dakar, Senegal, in West Africa. Connect the two with a straight line. Somewhere along this route there is a sunken submarine from World War II, filled with two tons of gold. To find the treasure sub you will have to draw an ocean profile on the chart provided.



1. Use the data to plot the depth of each point onto the chart, then connect the dots.
2. Label the two continental slopes—the parts of the ocean profile that show the steep drop from the continental shelf to the deep ocean plains.
3. Name two parts of the Atlantic that have depths of six kilometers.
4. Label the area of the Mid-Atlantic Ridge.
5. Now you're ready to locate the sunken treasure sub. It is located at the data point approximately two thousand kilometers west of the Cape Verde Islands and east of the Mid-Atlantic Ridge. How deep is it? Mark the spot on your profile.
6. Answer these questions on another sheet of paper.
a. Do you think you'll send down a team to look at the sub, or will you use a remotely operated vehicle?
b. Do you think that you'll make your base of operations the Cape Verde Islands or the Bahamas? Why?
c. What will you do about preserving the memory of sailors who went down with the sub?
d. Why does gold stay preserved in the deep? What happens to other materials that have been there for fifty years?

Point Location	Approx. Ocean Floor Depth in km.
1	1.2
2	above sea level
3	5.0
4	5.9
5	6.3
6	5.8
7	2.0
8	3.0
9	2.0
10	3.5
11	5.5
12	6.0
13	5.0
14	above sea level
15	1.8
16	above sea level

Resources

Online resources

The September/October 1995 issue of the Office of Elementary and Secondary Education's quarterly curriculum guide, *Art to Zoo* (**http://educate.si.edu/art-to-zoo/azindex.htm**), explores the relation between the world's oceans and the weather. A background essay, four lesson plans, and activity sheets help teach students about currents and navigation, coastal and inland climates, and changes in weather due to El Niño.

Visit Ocean Planet online at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**.

Using the Exhibition Topic Outline, look under Ocean Science to become fully immersed in ocean exploration. Under the Resource Room, go to the Image Catalog for photographs and illustrations of submersibles and other equipment used to plumb the depths of the sea. To view the latest images of the ocean compiled from satellite and sonar data, look at the National Oceanic and Atmospheric Administration's global gravity map at **http://www.ngdc.noaa.gov/mgg/announcements/announce_predict.html**.

Resources for students

Conley, Andrea. *Window on the Deep: The Adventures of an Underwater Explorer*, Sylvia Earle. New York: Franklin Watts, 1991.

Simon, Seymour. *Oceans*. New York: Morrow Junior Books, 1990

Waters, John F. *Deep-Sea Vents: Living Worlds without Sun*. New York: Cobblehill Books, 1994.

Resources for teachers

Duxbury, Alyn C., and Alison B. Duxbury. *An Introduction to the World's Oceans*. 4th ed. Dubuque, Iowa: William C. Brown, 1994.

Whipple, A.B.C. *Planet Earth: Restless Oceans*. New York: Time-Life Books, 1983.

Sea Connections

Some people go whale watching. Some people long to swim with dolphins. Others earn their livelihood fishing for giant tuna in a vast ocean. These marine animals capture our attention and our imagination. We have a connection to all the living things of the ocean, from the microscopic floating plants that supply us with the oxygen we breathe to the huge blue whale that fills its belly with a ton of krill. Microscopic or oversized, plant or animal, from muddy shoreline to deep ocean floor, the ocean's living things attest to its endless variety, its biodiversity. Scientists say that there may be millions more species than we know swimming, floating, and crawling in the deep oceans and as yet unseen by human eyes. With the aid of submersible technology, entire new ecosystems are being discovered. Each ecosystem consists of a community of living things that interact with one another in complex relationships in unique conditions of water temperature, salinity, chemical composition, and currents. ar below the surface of the ocean, where no sunlight reaches, hot water laced with chemicals spews out of cracks in the ocean floor. These cracks (hydrothermal vents) occur most often along the mid-ocean ridge, where Earth's crustal plates are spreading apart. Water reaching temperatures of four hundred degrees Celsius and chemical compounds such as hydrogen sulfide billow out from the vents. At certain vents, as the hot, sulfide-rich water comes in contact with cold seawater, metal sulfides precipitate out. The chemicals pile up into structures that resemble chimneys, which scientists call "black smokers." Scientists have found one black smoker that is as tall as a fifteen-story building. Can living things survive in such a place? The answer is yes. n 1977, scientists aboard the submersible *Alvin*, exploring five thousand feet below the surface of the Pacific, saw large, four-foot-tall tube worms, some with bright red plumes, living around a hydrothermal vent. Later laboratory investigation revealed that the unusual worms had no digestive system but instead

contained about 285 billion bacteria per ounce of tissue! In this sunless world, a type of sulfur-loving bacteria was the worms' food source. Clouds of bacteria, appearing white in the lights of the sub, were able to use hydrogen sulfide as an energy source. In most other food chains, plants convert carbon dioxide into food using sunlight during *photosynthesis*. These peculiar bacteria were able to convert hydrogen sulfide into food during *chemosynthesis*. Also found around the vents, feeding on the water rich in chemosynthetic bacteria, were certain kinds of clams and mussels. At this great depth and pressure, some species of octopus prey upon these shelled invertebrates. But when the hot water and chemicals coming from the vent slow down to a trickle, the animals disappear. n the past twenty years, more than three hundred species have been identified in this unique environment. Similar vent organisms have been discovered at the base of the continental shelf, where the ocean water is sulfide-rich but not hot, as in the hydrothermal vents. These "cold seeps," as they are called, illustrate how little we know about the productivity of the ocean bottom. As far as scientists can tell, hydrothermal vents and cold seeps have not yet been affected by human activities. ar away in a tropical ocean is another distinctive marine ecosystem. One in four marine species on our planet lives in a coral reef, an underwater world like no other with its colorful variety of swimming and floating animals making their way among the branching corals. The food chain of the coral reef begins with photosynthetic algae, microscopic organisms that use sunlight to make food. Most of the algae live in harmony within the tiny coral animals themselves. Reef-building corals secrete a hard, stony shell of calcium carbonate that builds up over time and provides the habitat for reef animals. Colorful invertebrates such as the coral shrimp feed on algae and detritus around the coral, where they in turn may become dinner for small fish. Large, sleek, and silvery barracuda patrol the outer reef, preying on smaller fish such as the butterfly fish. However, there is trouble in this paradise: pollution from pesticides, sewage, and

soil run-off has damaged many reefs in the Caribbean and Pacific. The practice of dynamite fishing to stun fish and capture them for the aquarium trade has devastated reefs in parts of Asia, the South Pacific, and Africa. erhaps not as familiar to us is the frigid water of the polar ocean. The food chains of the polar ocean also begin with algae, including symmetrically shaped diatoms with hard silicate shells. Algae are eaten by tiny invertebrate animals, including shrimplike krill. In the ocean around Antarctica, krill are an important food source, eaten by a diverse group of animals including fish, baleen whales, and Adélie penguins. The penguins are in turn preyed upon by leopard seals. The top predator of the Antarctic is the killer whale, which eats penguins and seals. Thus overfishing of krill in polar waters may jeopardize not only krill, but whales, seals, and penguins too.

long more temperate seacoasts, kelp forests form another unique ecosystem. Kelp are brown algae that can grow as much as sixty centimeters in one day, ultimately reaching as long as eighty meters. Tiny crustaceans called copepods are among the animal plankton that feed on the floating algae and detritus in the Pacific along the California coast. Larger invertebrates, such as sea urchins and abalone, graze on the kelp and are in turn eaten by sea otters. The overharvesting of kelp and a decrease in water quality have impaired the productivity of these ecosystems. Discharge from nuclear power plants on the California coast raises the water temperature just enough so that more sea urchins and abalone survive and grow, eating kelp and diminishing the size of kelp beds. nderstanding the various marine ecosystems helps us to better understand the important connections among marine organisms and suggests how much we still have to learn about the oceans.

This understanding also raises warning flags about the necessity of monitoring human activity to keep these connections from being severed and to protect marine biodiversity.

Sea Connections Lesson Plan

Objectives

Identify producers and consumers from four marine ecosystems.

Describe the delicate balance among organisms in each environment.

Construct a food chain or web from a marine ecosystem.

List some of the human activities that can upset the balance in marine environments.

Materials

Student Page

Globe or world map

Playing cards to be copied and cut out

Heavy stock paper for photocopying or pasting cards

Scissors

Subjects

biology, geography, oceanography, political science, art

Procedure

1. Motivate students by rapidly spinning a globe and asking them to approximate how much of Earth is covered by ocean. Ask them to think about the variety of marine organisms and habitats that must exist on our watery planet, which is over three-quarters ocean. Then have students locate each of the following on a globe or world map: the Great Barrier Reef in Australia (coral reef); the Weddell Sea, Antarctica (polar ocean); Monterey Bay, California (kelp forest); and the Mid-Atlantic Ridge (hydrothermal vent). (If the Mid-Atlantic Ridge is not shown on your globe or world map, approximate its location by connecting Iceland and the Azores with a large letter C, or look at the map on page 11, the Sea Secrets Student Page.)

2. Using the introduction as a guide, describe to your students some of the amazing biodiversity of ocean life, including marine organisms in hydrothermal vents, coral reefs, kelp forests, and polar oceans. Challenge students to match each of the four ecosystems you have described with the correct location on the globe. Ask them to name the producers and consumers from each ecosystem. Producers always begin the food chain and, in the ocean, are generally algae, although chemosynthetic bacteria are the producers near hydrothermal vents. All the other organisms are consumers.

3. In advance, photocopy the three pages of playing cards and paste copies onto heavy stock paper. Cut each sheet into nine cards along the guide lines. Each complete deck will have twenty-seven playing cards and is suitable for a group of up to four players. After cards are cut out they may be laminated or stored in plastic sleeves designed to hold trading cards.

4. Divide students into groups of four or fewer. Pass out a deck of cards to each group and the Rules of the Game Page to each player. Read through the directions together. Make sure that students understand that they will be trying to collect all five cards from one ecosystem in order to see how they connect to each other. Tell students that only five organisms have been chosen from each ecosystem for the game, but that these representative organisms are part of much bigger food webs from each ecosystem. Read through the Disconnect and Reconnect cards to make sure students understand how they are used in the game.

5. As students start playing, circulate among the groups. As a player is carrying out the directions on a Disconnect card, have that student explain to you the relationship of the organisms within that ecosystem and tell in his or her own words the impact of the card.

6. As a student from one group wins, you might interrupt play to let that student describe the winning hand to the class. Use this as a jumping-off point to talk about how food chains and food webs connect the producers and consumers in an ecosystem. As the students resume playing, tell them that the winner from each group should lay out the winning cards to form a food web for other players to see. Then they can divide and trade the remaining cards so that each player has all five cards of one ecosystem—a winning hand.

7. Ask students to fill in their charts using their cards. Spot check the diagrams of each marine ecosystem. Student food chains and food webs should show a pattern of producers first, then primary consumers (those that eat producers directly), followed by predators. If students use arrows to connect the organisms, the arrow's point should mean "eaten by."

8. When students have finished their pages, discuss which of the Disconnect cards prevented them from winning. This can lead to a discussion of the international problem of overfishing. Explain to students that when too many people haul their fishing nets and cast their lines in the same waters, too few fish are left to reproduce. In addition, some fishing grounds have become polluted, so the overall result is a dramatic drop in the fish population. The overfishing problem is so great in some areas that the government has to limit or halt fishing until certain populations recover. Among those on the "hardest hit list" are the Pacific king crab and the Atlantic

cod and haddock. In 1991 the American Fisheries Society announced that about half the nation's stock of salmon was at risk. Even the mighty bluefin tuna, which can weigh fifteen hundred pounds and swim as fast as a speeding car, is down to only 10 percent of its 1980s population.

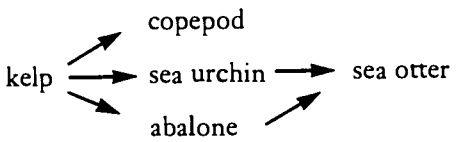
Commercial fishing practices of the past have also harmed nontarget species. In some places enormous driftnets up to sixty kilometers long were set over huge areas of ocean. The fine filaments would catch thousands of fish by the gills, but many other animals would get caught, too. Turtles, birds, sharks—even whales and dolphins—drowned in these nets. Loud cries from conservationists and governments brought about a ban on these driftnets, although shorter nets are still used close to shore. Other fishing gear still in use catches and kills young fish and other unwanted animals by mistake.

9. Ask students to imagine that they make their living catching fish, as some of their parents and grandparents did. Ask them to think about how they would feel if the government set a limit on their catch. Their first reaction might be to the loss of income; however, over the long term they should be concerned with finding ways to prevent the disappearance of the species.

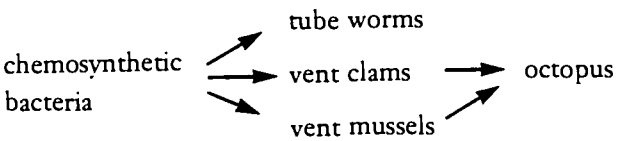
10. Ask students if they've ever played the card game Go Fish. Then ask them why the game they have just played could be called Don't Go Fish. They might answer that overfishing causes the reduction or loss of desirable and profitable species of fish and shellfish. It also disturbs the delicate balance of producers and consumers in each marine ecosystem. The purpose of the card game is to show how both natural events and human activities, such as overfishing, can disturb this balance and break the links that connect species in an ecosystem.

Sea Connections—Sample answers to food webs

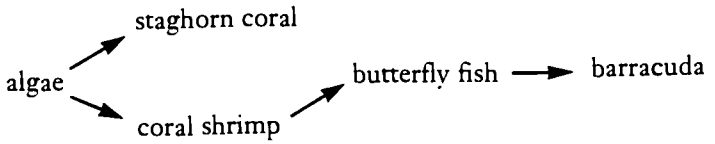
Kelp forest



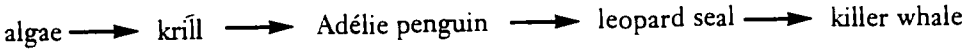
Hydrothermal vent



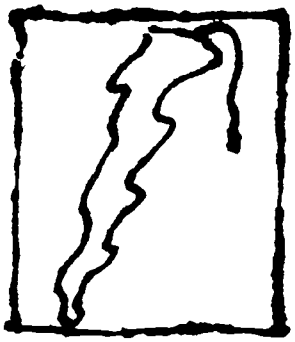
Coral reef



Polar ocean



Kelp

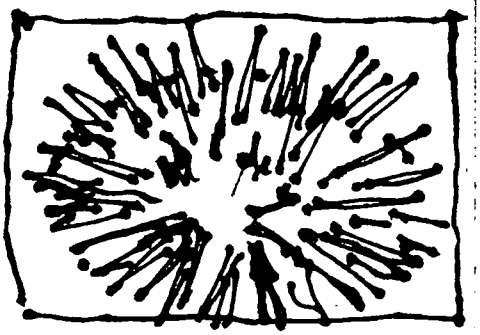


produces food

Copepod

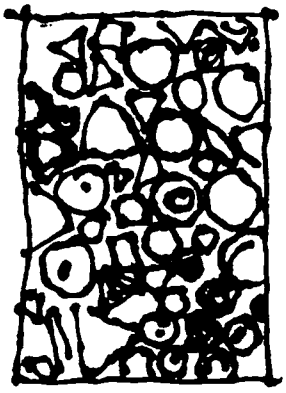
eats kelp and other algae

Sea urchin



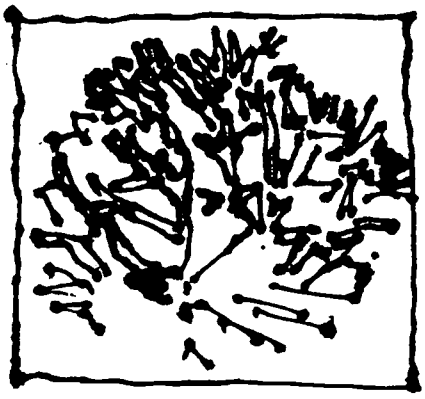
eats kelp

Algae



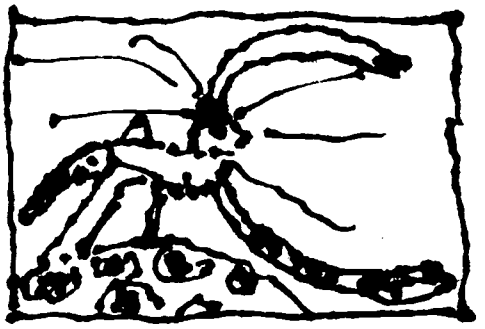
produce food

Staghorn coral



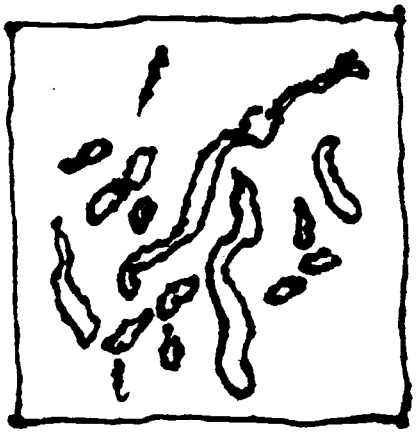
feeds on algae, other organisms

Coral shrimp



feeds around coral

Bacteria

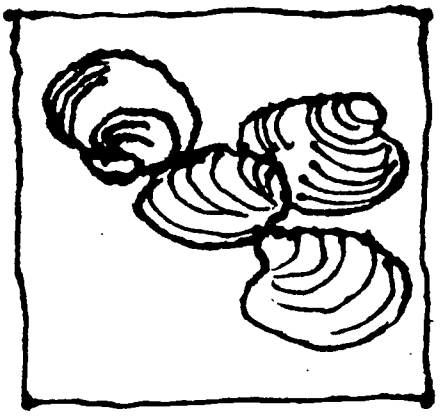


e food from chemicals

Tube worms

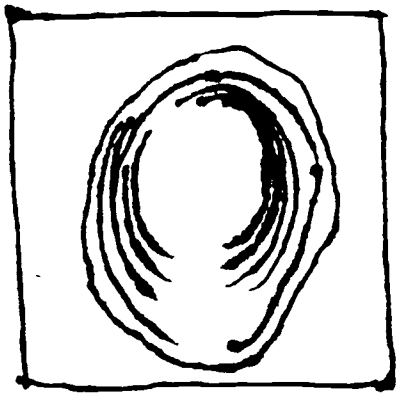
feed on bacteria

Clams



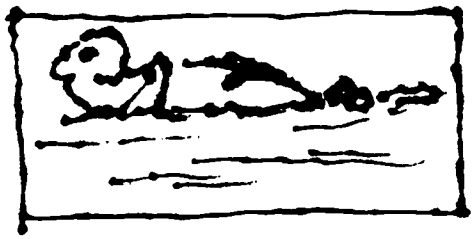
feed on bacteria

Abalone



eats kelp

Sea otter

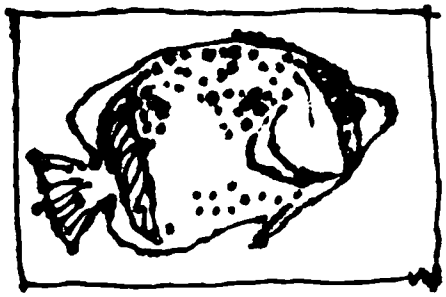


eats sea urchins and abalone

Disconnect

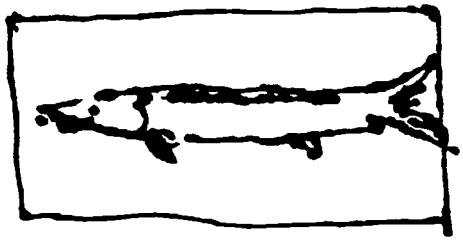
Kelp over-harvested!
Too much kelp has been harvested for use in industry. If you have any kelp forest cards, lose your next turn until the kelp forest recovers.

Butterfly fish



feeds around coral

Barracuda



eats other fish

Disconnect

Blast fishing!
Dynamite blows up a coral reef. Coral is destroyed and the fleeing fish are captured. If you have any coral reef cards, discard them and take new ones.

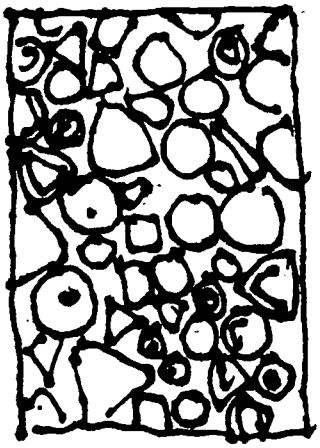
Mussels

Octopus

Disconnect

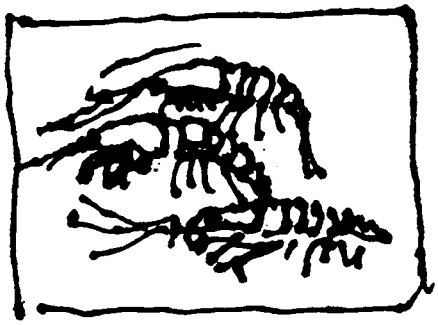
Smoker stops smoking!
A smoker stops spewing hydrogen sulfide. Few bacteria survive. The entir food chain is affected. If you have any smoker cards keep them, but you lose your next turn.

Diatoms



make food

Krill



eat algae

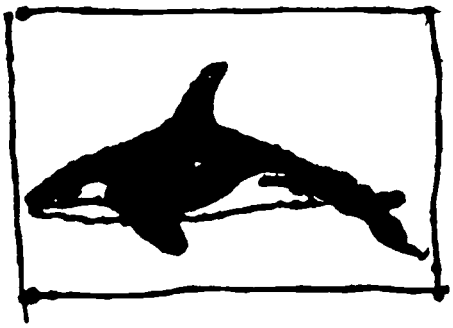
Adélie penguin

eats krill

Disconnect

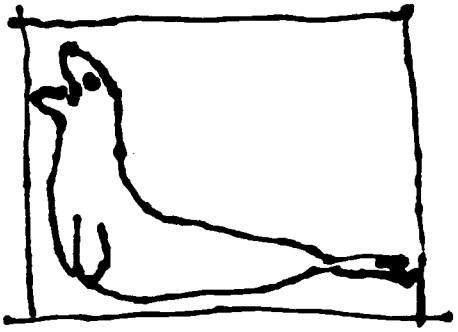
Overfishing of krill!
As a result, whales, penguins and seals are also in danger. If you have any polar ocean cards, discard them and take new cards.

Killer whale



eats penguins and seals

Leopard seal



eats Adélie penguins

Disconnect

Ocean pollution!
Pollution from pesticides, and sewage harms all ecosystems. Whatever cards you are collecting, you lose two turns until the ocean recovers.

Reconnect

Good news!
Because of international agreements on overfishing, give the player that went before you a needed card from your hand. Ask for and receive one card that you need from any other player.

Reconnect

Good news!
Because of international agreements on overfishing, give the player that went before you a needed card from your hand. Ask for and receive one card that you need from any other player.

Sea Connections Student Page

In Sea Connections,
you and your team will play a card game. The playing cards represent some of the plants and animals that are connected together in the food webs of four very different marine ecosystems. The cards show how these ocean producers and consumers depend on one another. The objective of the game is to collect all five cards from one ecosystem. What will get in your way are Disconnect cards. These cards describe events that harm ocean ecosystems and interrupt the connections among the living things that are found there.

Rules of the Game

1. Decide who will be the dealer in your group. The dealer shuffles the pile and deals each player five cards face down, then places the remaining cards in a pile face down. The dealer turns the first card up next to the rest of the deck to start a discard pile.
2. Group your cards by the icon in the top left corner. The icons represent:


kelp forest


coral reef


hydrothermal vent


polar ocean

The object is to collect five cards in one suit, which will include all the animals and plants from one ecosystem. For example, if you were dealt two cards from the coral reef, you may wish to collect all the cards from that ecosystem. (There are four suits, so each player should be trying to collect a different suit.)
3. When it is your turn, pick up the top card from the pile. If you don't need it, place it face up on the discard pile. If you wish to keep it, discard a different card from your hand. If you pick up a Disconnect card, use it during that turn. If you are dealt a Disconnect card, use it during your first turn. If you are dealt more than one Disconnect card, use one at each turn. You may use a Reconnect card at any time. Make sure that you finish each turn with five cards.
4. If the player before you discards a card that you want, you may pick it up instead of drawing from the face-down pile.
5. The first person to collect five cards in one suit wins. If no one wins the first time through the deck, the dealer shuffles the cards in the discard pile and you continue playing.

Sea Connections Data Chart

What suit did you collect?

What are the some of the living things found in this marine ecosystem?

Draw a food chain or food web that shows how the producers and consumers in this ecosystem are related. Use arrows to mean "eaten by . . ."

Resources

Resources for students

Online resources

Visit Ocean Planet online at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**

Using the Exhibition Topic Outline, choose Ocean Planet Marine Life Facts, Creatures of the Thermal Vents, The Living Reef, and Aliens Among Us (under Educational Materials in the Ocean Planet Floor Plan); and Threatened Habitats and Fishing Issues (under Oceans in Peril). Click on "Resource Room" to link to such resources as the Electronic Zoo.Visit the Marine Biodiversity Sculpture (under Ocean Science) or use the Image Catalog (under Resource Room) for photographs of organisms from each of the marine ecosystems mentioned in the preceding activity.

Brower, Kenneth. *Realms of the Sea*. Washington, D.C.: National Geographic Society, 1991.

Cerullo, Mary M. *Coral Reef: A City That Never Sleeps*. New York: Cobblehill Books, 1996.

Charton, Barbara. *The Facts on File Dictionary of Marine Science*. New York: Facts on File, 1986.

Fodor, R. V. *The Strange World of Deep-Sea Vents*. Springfield, New Jersey: Enslow Publishers, 1991.

Resources for teachers

Duxbury, Alyn C., and Alison B. Duxbury. *An Introduction to the World's Oceans*. 4th ed. Dubuque, Iowa: William C. Brown, 1994.

Earle, Sylvia A. *Sea Change, A Message of the Oceans*. New York: G.P. Putnam's Sons, 1995.

he ocean is the source of many materials, from ores mined from its depths to relaxing mineral salts for a bath. Exquisite mother-of-pearl inlay, decorative shells, and pearl jewelry are found in gift shops worldwide. And whether your tastes run to the exotic, like yellowfin tuna sushi, or the mundane of fast food milkshakes, products from the sea are probably in your diet. Many species of vertebrate and invertebrate marine animals as well as marine algae are important sources of food worldwide. xamine the foods in your own kitchen and you may find the terms "alginate" and "carrageenan" on the labels. Carrageenans are compounds extracted from red algae that are used to stabilize and jell foods and pharmaceuticals. Brown algae contain alginates that make foods thicker and creamier and add to shelf life. They are used to prevent ice crystals from forming in ice cream. Alginates and carrageenans are often used in puddings, milkshakes, and ice cream. The commonly used color additive beta-carotene often comes from green algae as well as many vegetables, including carrots. n the grocer's shelf and in the pharmacy, in industry and in the arts, the ocean is a resource without equal. However, exploitation of these natural resources carries with it the responsibility to use them wisely and preserve them globally.

28

Ocean Market Lesson Plan

Objectives

Identify some consumer goods that come from the ocean.

Classify these items into groups and identify their source.

Calculate the cost of buying such goods.

Materials

Student Pages A and B

Optional: labels from products containing algae; menu from a seafood restaurant

Subjects

biology, mathematics, nutrition, social studies

Procedure

1. Begin by asking students to think about the variety of things that come from the sea. You might have a student write the suggestions on the board as they are mentioned. Students will probably name foods such as fish and shellfish. Ask them to categorize their suggestions into "vertebrates" and "invertebrates." Under vertebrates they might include bony fish with which they are familiar such as tuna, salmon, flounder, cod, halibut, and sole. Less familiar but of commercial value are pollack (used in imitation crabmeat) and Mako shark (a vertebrate with a cartilage rather than bone skeleton). Ask students about the relative sizes of these fish. They might know that a tuna, for example, may weigh hundreds of pounds whereas a flounder weighs only several pounds. Ask if students have ever noticed the symbol for "dolphin safe" on a can of tuna. They should know that it means the tuna were caught using fishing techniques that do not endanger dolphins. (All tuna are caught this way today.) Under invertebrates students may think of shrimp, crabs, clams, mussels, oysters, and lobsters. Shrimp, crabs, and lobsters are crustaceans; clams, mussels, and oysters are mollusks with a hard, calcified shell. Most of the time when we refer to a "seashell," we mean the remains of the hard shell of a mollusk such as a conch, snail, nautilus, or abalone. The inside of an abalone shell is a source of mother-of-pearl.

2. Ask students if they have ever been to a seafood store or seafood restaurant. Ask questions about the source of this seafood and whether it was shipped from far away. Ask if it is important to keep seafood on ice. Tell students that many commercial fishing boats are actually factories on which workers clean the fish and freeze it immediately to ensure freshness at the market. If you have a price list from a local seafood store or a menu from a restaurant, discuss it with students. If regional dishes containing seafood are popular in your area, ask students to bring in recipes for them. If fishing is an important regional activity, ask students to bring in pictures or "fish stories" to share with the class.

3. Some students may suggest seaweed as a food. Types of algae are eaten most typically in Japanese cooking. Nori and hijiki are two types generally found in specialty stores. Nori is the dark brown variety used to roll rice and fish for sushi. Tell students that even if you live thousands of miles from the ocean, the vanilla shake that you enjoy at your local fast food restaurant probably contains some seaweed because carrageenans are usually added to thicken shakes. If you have any labels from packaged foods or personal care products that contain alginates or carrageenans, show them to students and explain what these compounds do. Ask students to look for these compounds on the labels of products they have at home or notice them the next time they visit a supermarket or drugstore.

4. Tell students that they will be doing an activity that will give them some imaginary money to

go on a Sea Shopping Spree. Hand out the student pages and tell students that they will visit the Fair Harbor Mall, where they will browse for gifts at Fantasea Creations; buy health and beauty products at Mermaid's Tresses; have lunch at the Ship's Galley; then take home some fresh seafood and videos for the evening. Have them "enter" the mall at the welcome sign. They might want to plan their own route; the order suggested above is one logical way.

5. Ask students why they would want to buy the seafood near the end of their shopping spree. (Because seafood should be kept cold.) If students would rather skip buying or eating seafood, you might turn the discussion toward how people have made a living from the sea throughout history. Ask students why they think seafood prices seem so high. They may suggest that some kinds of seafood must be flown in from other regions as suggested by the names. Tell them also that the season for certain kinds of fish and shellfish is limited and certain species may have been overfished in local waters.

6. Students may work independently to come up with their personalized shopping list and tally the cost. Under the category "Where did it come from?" students should decide if the item comes from algae, an invertebrate animal, a vertebrate animal, or a mineral. When they have finished, have them compare their shopping lists and how much money they spent. Even by choosing the most expensive item at each stop, students should still stay within the budget. Have them discuss their answers about the source of each item.

Fresh Catch Seafood Maine lobster and Gulf shrimp are invertebrates (crustaceans); Atlantic Mako shark is a vertebrate, although sharks have no bones, only a cartilage skeleton; Nova Scotia salmon, yellowfin tuna, and flounder are vertebrates.

Ship's Galley Shrimp are invertebrates. Sushi is rolled nori (algae) with rice and fish (vertebrate); flounder is a vertebrate, although the stuffing might contain shrimp, an invertebrate. Pudding and ice cream might contain algae in the form of carrageenans or alginates.

Fantasea Creations The treasure chest contains mother-of-pearl, which usually comes from abalone, an invertebrate. Scrimshaw in the key ring traditionally comes from whale tooth or bone (vertebrate). However, tell students that sperm whale teeth and walrus tusks are protected. Pearls come from the oyster, an invertebrate (mollusk). You might tell students that oyster shells are also used in natural calcium supplements. Shells such as a conch as well as those that would be used in a necklace come from shelled invertebrates, mollusks. Red coral in a pendant comes from the coral-producing invertebrate

animals (coelenterates). Tell students that black coral is endangered. In discussing these answers, pose this question to students: "Suppose you saw a beautiful item made from the shell of an endangered turtle. Would you buy it?" This may lead to a discussion of being a responsible consumer and not buying goods that threaten marginal species.

Mermaid's Tresses

Seaweed shampoo and kelp iodine supplement contain algae. Cod liver oil (which often comes from Norwegian cod, a vertebrate ocean fish) is a source of omega-3 oil. Natural sponge is the dried outer framework of an invertebrate (porifera). Sea bath salts contain minerals that make the sea salty: sodium chloride, magnesium chloride, and potassium chloride, among others. Mention to students that there is a huge potential for pharmaceuticals from the ocean, particularly from coral reefs. The diversity and density of coral reef organisms rivals that of the rainforest. Denizens of the reef have evolved the ability to synthesize unusual compounds to avoid being eaten or grown over. These compounds could prove to be lifesaving pharmaceuticals for humans.

Video Harbor

Twenty Thousand Leagues Under the Sea is a Jules Verne fantasy that includes a battle with a giant squid, an invertebrate. *Moby Dick*, based on Herman Melville's novel, is the story of the hunt for a sperm whale, a vertebrate. If students are unfamiliar with these classics, you might get copies of the books from the library to have on hand. Also, encourage students to make a list of other videos about the ocean, such as *Jaws* or *The Abyss*.

7. To follow up the discussion of the importance of products from the sea, have students use the library or go online to find out how scientists use organisms from the sea in research. For example, sea urchins are used in embryology, and sharks are studied in immunology because of the shark's amazing immunity to diseases such as cancer.

8. Encourage students to try their hand at making a work of art inspired by the sea. They might try carving "scrimshaw" out of a bar of soap, using fishbones to make jewelry, or using seaweed to make a picture. Students might also make a display case for a shell collection.

Ocean Market

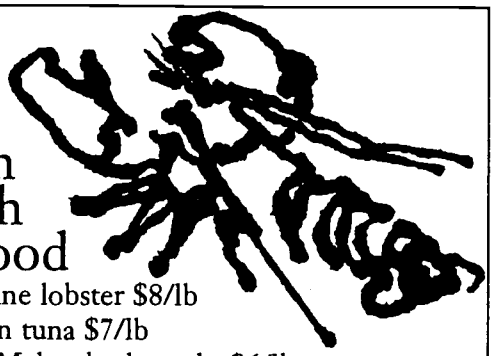
Student Page A

You are about to go on an imaginary Sea Shopping Spree at the Fair Harbor Mall. Imagine you have been given a hundred "clams" ($100) to spend at the mall. But the "catch" is that you have to buy certain things on your shopping list to take home. Look at some of the ocean products that are advertised at each store. List the ones you would buy in the chart. Tally up the total cost to stay within your budget.

Of the items you purchase, you will find that some come from vertebrate animals and some from invertebrates. Some items are made with substances that come from algae and some are made with minerals from the sea. In the column under "Where did it come from?" identify the source of each item you select.

Item	*Your selection*	*Cost*	*Where did it come from?*
A gift for an important person in your life.			
Three personal care products for you or someone else.			
Lunch for you and a friend while shopping.			
Fresh seafood (at least two pounds) to take home for dinner.			
A video or two to rent for the evening.			
Total (not to exceed $100)		33	

Ocean Market
Student Page B



Fresh Catch Seafood

Live Maine lobster $8/lb
Yellow fin tuna $7/lb
Atlantic Mako shark steaks $6/lb
Nova Scotia salmon $8/lb
Jumbo gulf shrimp $14/lb
Local flounder $9/lb

Ship's Galley

Shrimp cocktail, Sushi, or
Stuffed flounder
Only $8.00

Pudding, Ice Cream $1.50

Welcome to the
FAIR HARBOR MALL

Video Harbor Rentals $2

Classics Week
Moby Dick
20,000 Leagues Under the Sea

Fantasea Creations Unique Gifts

Mother-of Pearl Treasure Chest $30
Scrimshaw Key Ring $29
Pearl Earrings $30
Seashell Necklace $20
Coral Pendant $25
Conch Shell $20

Mermaid's Tresses

Health and Beauty Products from the Sea

Seaweed shampoo $4.50
Kelp iodine supplement $4
Cod liver oil $5
Natural sponge $3
Relaxing sea salts for the bath $6

Resources

Online resources

Visit Ocean Planet online at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**

Using the Exhibition Topic Outline, go to PharmaSEA and SEAfoods under SeaSTORE. A lesson plan and activity sheet are available by clicking on "Sea Store Lesson Plan: There Are Algae in Your House!" under Educational Materials in the Ocean Planet Exhibition Floor Plan. Under Resource Room, use the Image Catalog to get photographs and illustrations of specific marine organisms and products suggested in the activities above.

Resources for students

Pringle, Laurence P. *Coral Reefs: Earth's Undersea Treasures*. New York: Simon and Schuster, 1995.

Taylor, Barbara. *Coral Reef*. London: Dorling Kindersley, 1992.

Resources for teachers

Benchley, Peter. *Ocean Planet: Writings and Images of the Sea*. Edited by Judith Gradwohl. New York: Harry Abrams, in association with the Smithsonian Institution, 1995.

Chapman, V. J., and D. C. Chapman. *Seaweeds and Their Uses*. New York: Chapman and Hall, 1970.

Earle, Sylvia A. *Sea Change, A Message of the Oceans*. New York: G.P. Putnam's Sons, 1995.

ore than 60 million gallons of oil enter the oceans every year, but it's not reported on the news. That's because this oil seeps from oil-bearing rock layers into the ocean as part of a natural process. When tankers running aground spill oil, that's news, and currently these accidents deposit about 37 million gallons of oil into the ocean every year. The largest amount of oil entering the ocean through human activity is the 363 million gallons that come from industrial waste and automobiles. When people pour their used motor oil into the ground or into a septic system, it eventually seeps into the groundwater. Coupled with industrial waste discharged into rivers, oil becomes part of the run-off from waterways that empty into the ocean. All of this oil affects ocean ecosystems. hen an oil spill occurs in the ocean, the oil may spread across miles of open water and up onto beaches, littering them with tar balls. The intertidal zones—

coastal areas that are the habitat for fish, birds, and other wildlife—are often the most vulnerable. Animals may perish when the oil slicks their fur or downy feathers, decreasing the surface area so they are no longer insulated from the cold water. Or the animals may ingest the oil, then become sick or unable to reproduce properly. hen an oil spill occurs along a coastline, it affects the human population as well as wildlife. Emergency equipment and personnel must be rushed to the scene. The responsible party must be identified to determine who will pay for the cleanup. Usually the cleanup is a group effort by oil companies, government agencies, local groups, and volunteers. People rescue and clean birds and animals and painstakingly scrub the oil from the rocky shores with brushes and detergent. Coming in by sea and by air, crews skim the spreading oil from the water's surface. Oil that cannot be skimmed is emulsified—that is, droplets of oil are scattered into tiny particles that will then float away and disperse out to sea. ometimes microscopic helpers are put to work. Genetic engineers have developed oil-eating bacteria that can be used to ingest the oil, to clean up long after the crews and volunteers have left. The experience gained from several well-publicized oil spills has ushered in an era of greater understanding and international cooperation with regard to containing spills and avoiding environmental disasters that affect our global ocean. One bright spot of news is that ecologists revisiting oil spill sites have found marine population recovery better than they had predicted.

Pollution Solution

Lesson Plan

Step 1

Objectives

Predict the effects of an oil spill on a marine environment.

Establish a list of solutions to avoid unnecessary oil pollution.

Materials

Student Page A

Optional: additional photographs or articles about oil spills

Subjects

biology, chemistry, social studies

Procedure

1. Introduce the topic of oil pollution and how it affects the global ocean. Make a pie chart to show the actual small percentage of oil (5 percent) that enters the ocean through oil spills. Then discuss oil spills with which students may be familiar, such as the spill off the coast of Rhode Island in January 1996 and the one in Prince William Sound in Alaska in 1989. You may wish to check your library or online sources for magazine and newspaper articles about actual oil spill events, perhaps an incident that occurred close to your region to make the topic more relevant to students.

2. Explain to students that crude oil is taken directly from its rocky source below ground or under the sea. It is often transported in huge tankers across vast distances to oil refineries. There the crude is distilled and refined into many familiar petroleum products. During the distillation process, petroleum is heated to extremely high temperatures to separate it into various components such as gasoline and kerosene. Students may not know that petroleum is used for waxes contained in petroleum jelly, lipstick, and many personal care products. Each of these petroleum products has different chemical characteristics. In general, the molecules that make up oils and waxes adhere to one another and are less dense than water; thus, they float on the water's surface without mixing. However, the currents and wind out on the open ocean cause the oil in an oil spill to spread and travel away from the spill site.

3. After an initial discussion, hand out Student Page A. In this page students can use problem-solving skills to decide what strategies they would use if they were actually cleaning up an oil spill. They can work in small groups and brainstorm to come up with answers cooperatively.

Possible answers, page 38:

1. Problems: Currents and wind may carry the oil over a huge area of the sea.

Strategies: Bring in equipment by air or boat to skim the oil from the water's surface before it spreads.

Problems: Rocks will get covered with oil; animal habitats will be harmed.

Strategies: Have crews scrub the rocks with brushes and detergent.

Problems: The oil will wash up on shore, making cleanup difficult and affecting wildlife.

Strategies: Have crews take away or sift through oily sand and rescue wildlife.

2. These agencies have information about winds, currents, tides, and weather patterns affecting the area.

This agency has information about which species of fish and wildlife need protection.

3. Water is denser, so oil floats on it.

4. The oil will probably spread out away from the spill, staying on top of the water rather than sinking.

Pollution Solution
Student Page A

Suppose you are in the business of cleaning up oil spills in the ocean. Your team has just received word of a tanker leaking oil in the Pacific Ocean. How will you use your resources to effectively clean up the oil and prevent it from spreading? Brainstorm in a small group to predict what will happen during the oil spill, then plan your cleanup strategies.

1. What special problems arise if an oil spill occurs in the open ocean, on a rocky coast, or near a sandy beach? (Hint: You might think about things like currents, surface area, and habitat for wildlife.) List the kinds of equipment and vehicles you might need to do the cleanup at each site in the data chart below.

Oil Spill Site	*Special Problems*	*Possible Strategies for Cleanup*
Open ocean		
Rocky coast		
Sandy beach		

2. What kind of information would be important to find out from these government services?

Weather Service or Coast Guard

U.S. Fish and Wildlife Service

3. Which do you think is denser, oil or water?

4. What do you think will happen to the oil (or other petroleum product) as it spills out of a tanker into the ocean?

Pollution Solution
Lesson Plan Step 2

Objectives

Make a model of an ocean oil spill.

Evaluate the efficiency of oil spill cleanup methods.

Materials

For each group of four students, a shallow oblong pan, water, vegetable oil, cotton balls, teaspoon, medicine dropper, timer, plastic container for waste-water, and plastic bag for discarded cotton balls.

Student Page B

Optional: liquid detergent, brush, bird feather, wire whisk, pebbles

Subjects

physics, mathematics

Procedure

1. Advise students of the activity the day before so they can wear washable clothing. Divide students into groups of four. Each group can carry out the simulated oil spill and cleanup cooperatively. Arrange to have all the materials students need at each workstation. Guide students as they read through the directions on how to make an oil spill and then clean it up. Advise them to use their resources wisely, as they will be "charged" for each piece of equipment and the disposal of the oil.

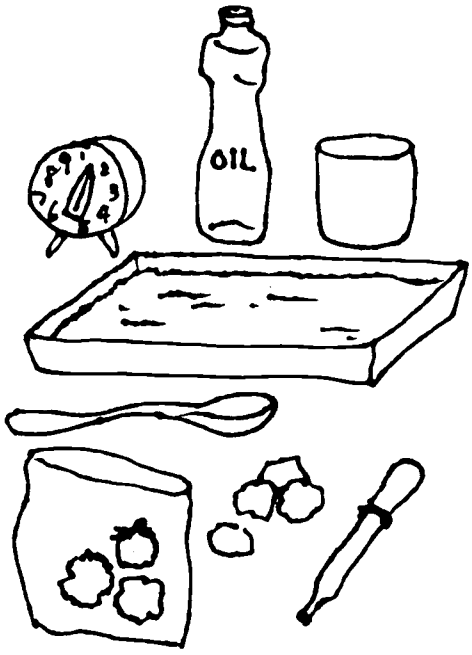
2. In carrying out the activity, limit the "disaster" to a portion of the classroom or lab where surfaces can be wiped dry. Use clear plastic bags to collect the oil-soaked cotton balls so that students can count them and be charged accordingly. Use quart-sized, wide-mouthed plastic containers for the wastewater, which can then be carried to a sink for disposal. Have paper towels on hand to clean up spilled water and advise students of slippery floors.

3. Options: Before students begin, demonstrate that "oil and water don't mix" by pouring some oil into a clear container of water. Have students observe how the oil forms a layer on top of the water. Then use a wire whisk to stir up the oil and water. Students will see how oil can be made into smaller and smaller droplets that will disperse in the open ocean where there is room to spread out. This is similar to one of the techniques used in cleanup operations. If students use the whisk in their pans, it will make skimming the oil much more difficult, but you might challenge some students to do it anyway. Another interesting demonstration is to dip a bird feather in oily water and have students try to clean the feather using liquid detergent and a brush.You can also challenge one group to simulate an oil spill that hits a rocky coast by using pebbles at one end of the pan. Have students compare the amount of surface area for that cleanup with an oil spill on the open ocean.

4. After the groups have worked on their oil spills for twenty minutes, have them tally the cost of their efforts and clean up their spill sites. Students can then answer the discussion questions and compare their results.

Pollution Solution
Student Page B

In this activity you will make your own "ocean" in a pan of water. You can simulate your own very limited environmental disaster—and then clean it up! Work with your group to set up the materials shown below.



1. Use the shallow pan filled halfway with water as your model ocean. Add a teaspoon of vegetable oil to the middle of the pan to simulate a leaking oil tanker.

2. While one group member releases the oil in the center of your ocean, another begins timing.

3. After one minute has passed, observe what happens to the oil. See how the oil is affected as another team member blows on the oil, simulating the wind.

4. Begin the cleanup of the oil using the available materials. You may take twenty minutes.

5. Try to do the cleanup efficiently because you will be "charged" for the use of each piece of equipment. No cleanup effort is free! Keep track of the time each technique is used. Use the chart below to calculate the cost of your efforts.

Pollution Solution Cost Sheet

Equipment and Techniques	*Cost*	*Minutes of Use or Number Used*	*Total Cost*
Medicine dropper "skimmer"	$100/minute		
Cotton ball	$20/piece		
Waste disposal:			
Discarded cotton ball	$50/each		
Container for wastewater	$1,000/each		
Labor	$1,000/person/minute		
Total cost			

Pollution Solution

Student Page B

Use the back of this page or a separate sheet to answer these discussion questions.

1. Did you clean up your oil spill within twenty minutes? Did everyone agree on how clean the pan was?

2. Which technique seemed to work best?

3. Make a chart of your class results. Which group cleaned its ocean at the lowest price?

4. What importance does immediate response have in cleanup efforts?

5. Suppose class members used different kinds of oil. Would their results be the same? Do you think all petroleum spills behave the way vegetable oil does? Why or why not?

Pollution Solution

Lesson Plan Step 3

Objectives

Identify the problems caused to the environment and society by an oil spill and the subsequent cleanup operations.

Materials

List of fictitious characters (on page 44)

Optional: newspaper or magazine articles about oil spills

Subjects

social studies, language arts

Procedure

To get a sense of the impact of an oil spill, have a role-playing discussion. Ask students to play the parts of some or all of the fictitious characters listed here. Have each character write some notes that would be taken to a press conference held to find out what happened when a tanker went aground and caused an oil spill along a coastline. Some members of the class can be reporters, directing questions to any of the participants. Other members of the class can record the discussion in writing or videotape it.

Fictitious characters

Captain Shipley: captain of the tanker that went aground

Ms. Petrol: spokesperson for the Giant Oil Corporation

Mr. Swab: head of cleanup operations

Ms. Cirrus: spokesperson for the U.S. Weather Service

Mr. Marchand: president of the local merchants' association

Ms. Greene: spokesperson for a national conservation group

Mr. Hook: spokesperson for the local fishing community

Ms. Wright: president of the Town Council

Mr. Labb: scientist at Innovate Corp., a bioengineering firm

Ms. Ivory: salesperson for Kleen-Up Supplies, Inc.

Mr. Byrd: conservationist from the U.S. Fish and Wildlife Service office

Ms. Goodley: spokesperson for volunteers

2. The reporters should ask questions about (a) the chain of events that led to the oil spill, (b) how each party helped with the cleanup operation, and (c) how the spill affected their lives. Student responses will vary widely but should be consistent with the attitude and professional knowledge suggested by each fictitious character's name and position. Students should be able to conclude that the responsibilities for cleanup must be shared and that local people are affected by the oil spill long after the cleanup crews have left.

3. Optional: Have students use their library to access articles about recent oil spills. Encourage students to become aware of local or regional events that are similar, if not as large.

Resources

Resources for students

Anderson, M. K. *Oil Spills*. New York: Franklin Watts, 1990.

Carr, Terry. *Spill! The Story of the Exxon Valdez*. New York: Franklin Watts, 1991.

Resources for teachers

Benchley, Peter. *Ocean Planet: Writings and Images of the Sea*. Edited by Judith Gradwohl. New York: Harry Abrams, in association with the Smithsonian Institution, 1995.

Bulloch, David K. *The Wasted Ocean*. New York: Lyons and Burford, 1989.

Earle, Sylvia A. *Sea Change, A Message of the Oceans*. New York: G.P. Putnam's Sons, 1995.

Keeble, John. *Out of the Channel: The Exxon Valdez Spill in Prince William Sound*. New York: HarperCollins, 1991.

"Rescuers Create a MASH Unit for Hundreds of Stricken Animals." *New York Times*, 4 April 1989.

Online resources

Visit Ocean Planet online at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**

Using the Exhibition Topic Outline, go to Oil Pollution under Oceans in Peril for graphs showing oil pollution data. Under Resource Room, go to the Image Catalog to get photographs and illustrations of specific images suggested by the topics in the activity.

seacoast is the dynamic border between two worlds—the terrestrial and the marine. In the realm of life science, we can observe marine animals that inhabit the shoreline and tidepools. In the realm of Earth science, we can observe how the ocean's currents, waves, and winds sculpt the shoreline, alternately carrying off and depositing sand. From the air, you can actually see the waves create a perfectly scalloped beach on Nantucket Island. ot only do these forces shape the land, they affect the living populations. Sometimes animals that inhabit deeper water are thrown off course. They come close to the shoreline and may actually be found on the beach. They may be injured, sick, or disoriented and soon become cold, hungry, or dehydrated. Such is the case for various species of dolphin, porpoise, seal, whale, and turtle that become stranded along the Atlantic coastline. But there is help for some animals. In many locations, when beached animals are sighted, professionals and volunteers are on the scene. Sick, cold, or injured animals are immediately placed in a rehabilitation program with the intent of getting them well enough to be returned to their natural habitat. Often the animals are tagged with a transmitter for future tracking. ome of the large marine animals that are regularly tracked along

the
Atlantic coast are
cetaceans, pinnipeds,
and sea turtles. Cetaceans
are marine mammals such as
whales, dolphins, and porpoises;
pinniped refers to seals and walruses. If an
individual from one of these populations is seen on shore, the observer can call in the sighting to an agency that helps such creatures; if possible, a rescue team is dispatched. Every acknowledged animal sighting is assigned a number and becomes part of the database for that species. If the animal requires treatment of an injury or disease, it may be given a temporary tank to live in until it can recuperate and be returned to the wild. ea turtles make up another group of marine animals that become stranded along the Atlantic coast. Turtle species are of particular interest because they are either endangered or threatened worldwide. (Endangered species are in danger of becoming extinct; threatened species could easily become endangered if present trends continue.) Sea turtles are reptiles that have existed virtually unchanged for eons; human activity has decimated their populations. In the days of the great sailing ships, these large reptiles often found their way into the cook's stewpot. Their heavy shell or carapace was a treasured source of decorative shell. Even in recent decades, their eggs have been plundered for food. uring their long lives (fifty years or more), these reptiles may travel great distances; tagging individuals is important for

studying their behavior and monitoring their dwindling populations. Stranded sea turtles are sometimes reported up and down the Atlantic coast as well as on the Gulf Coast. The causes are many, including water pollution, disease, attack by a predator, or entanglement in fishing gear. To prevent turtles from getting caught and drowning in fishing nets, some Gulf shrimp trawlers use nets equipped with a turtle exclusion device that has been effective in protecting turtles. n the northeast Atlantic coast, animals are sometimes found close to the beaches, especially in the winter months. They may be driven toward the shore by the cold Labrador current in Cape Cod Bay, or the northwest winds along Long Island's north shore may pin the turtles against the shore or trap them in bays. These animals become "coldstunned"—chilled to the point where they are unresponsive and unable to eat to get their metabolic rate going. Coldstunned turtles must be gradually warmed, given warm fluids intravenously, and then force-fed to give them the nutrition they need. When their body temperatures have increased, they are placed in tanks and fed and cared for until they are sufficiently recovered to be released. he data in the activity reflect actual turtle strandings during the winter months of 1995 reported by the Okeanos Foundation on Long Island and the New England Aquarium in Boston, agencies that are authorized to rescue and rehabilitate marine animals.

Stranded Along the Coast Lesson Plan

Objectives

Plot stranding sites onto a map using latitude and longitude as well as compass directions with respect to coastal features.

Identify several species of marine animals that might become stranded; distinguish their characteristics and habitats.

Identify several coastal features and important currents.

Form hypotheses and make analyses based on the data.

Materials

Student Pages A and B

Optional: geological survey map of your area, compass

Subjects

social studies, biology, oceanography, mathematics

Procedure

1. Start a preliminary discussion by asking students if any of them has ever considered swimming a great distance—like across the thirty-mile English Channel, for example. Swimming the Channel between England and France is considered a great human feat, but for some of the champion swimmers of the animal world, thirty miles would be a drop in the bucket. Whales migrate over thousands of miles of ocean in just one season. Dolphins and seals play over hundreds of miles of coastal waters of the Atlantic and Pacific. But the real champs are sea turtles: because of their long life spans, they log hundreds of thousands of miles. It's not uncommon for a sea turtle from Mexico or South America to be found off the northeast Atlantic coast in summer. Green sea turtles swim thousands of miles to lay eggs on the same tiny island where their mothers laid their eggs. Their powers of navigation hold a fascination for us. But sometimes, for many different reasons, their journey is interrupted and the animals become lost or stranded. "Stranded" originally meant "beached." A beach was (and in England, still is) called a "strand." Sometimes a stranded turtle is found washed up on a beach. Other times, the animal is stranded inside a body of water and cannot get out into the open ocean. Tell students that they will be plotting real data for the locations of some sea turtles that were sighted during the latter months of 1995.

2. If you have a topographic map of your area, or other maps with which students are familiar, you might want to use them to review latitude and longitude. The accompanying map shows degrees of latitude and longitude divided into thirty-minute intervals; students will have to approximate between these intervals to plot some of their points. If you have a compass or any navigational aids, bring them in to discuss their use.

3. Hand out both student pages. To use the map, students may need to know the terms used to describe bodies of water and coastal features. Have them find the state names to get oriented to the map and perhaps show where this region is on a U.S. map. Ask them to read the names of the bodies of water and find an ocean, a gulf, a sound, and a bay. They should be able to distinguish among them and put them in size order. Tell them that bays are generally sheltered on three sides.

4. Discuss some of the terms used to describe coastal features. These include barrier beaches such as Fire Island. They are created by waves hitting the shore of the mainland, then dragging sand out and depositing it until it forms a sandbar. Eventually, the sandbar grows large enough to be an island, a buffer zone that protects the mainland from further erosion by water. On a U.S. map, have students find the barrier beaches along the coasts of Texas and North Carolina.

Waves also deposit sandbars that extend the shoreline into the ocean, creating a "point" such as Race Point in Cape Cod or Montauk Point on Long Island. The currents around the sandbar may flow at such an angle that they create a hook, for example, the "arm" extending northward from the "elbow" of Cape Cod.

The entire region of Long Island, Cape Cod, Martha's Vineyard, Nantucket, and Block Island was formed by glacial moraine and then modified by the ocean's waves. You might also tell students that many of the bays shown on the map contain salt marshes and estuaries (where rivers empty into salt water). Marshes, estuaries, and barrier beaches are all important wetland habitats that require management and preservation rather than destruction or development.

5. Have students begin plotting the points of the turtle sightings. They will find that these turtles were sighted in four areas: along

the south shore of Long Island near the barrier beach, along the north shore of Long Island, in Gardiner's Bay, and farther north in Cape Cod Bay. Give students some of the background on each of the following four turtle species. This will help them fill out their data tables and hypothesize about what caused each stranding.

Kemp's ridley sea turtle

(*Lepidochelys kempi*)—endangered.*

This is an extremely endangered species globally. Ridleys have gone from a population of four hundred thousand nesting females in the 1940s and 1950s to only about four hundred today. Within the region of the accompanying map, they live in certain areas of Long Island Sound, Block Island Sound, and portions of the Peconic Estuary. Some also live in Great South Bay. Generally, juveniles from two to five years old live in these areas. They eat primarily spider crabs and green crabs.

Loggerhead sea turtle

(*Carretta carretta*)—threatened.**

Long Island Sound and its bays are home to juvenile, or nonreproductive, loggerheads. Adults may be found along the south shore of Long Island and up to about forty miles offshore. Their diet consists of spider, horseshoe, green, and portunid crabs.

Green sea turtle

(*Chelonia mydas*)—threatened (endangered in Florida).

Green sea turtles are less abundant in this region than the other sea turtles, and their diet and habitat are not as well documented. They are usually found in shallow bays where there is more aquatic vegetation for food. Several age classes have been observed in this region.

Leatherback sea turtle

(*Dermochelys coriacea*)—endangered.

Although they are endangered, leatherbacks are one of the most abundant species of sea turtles in the region. They are found on the south shore of Long Island and in Long Island Sound but rarely in the bays. The population of older juveniles and adults eats mainly jellyfish. Tagged animals are known to have come all the way from French Guiana in South America. In parts of the Atlantic, leatherbacks have been known to reach over eleven feet and four thousand pounds.

*Likely to become endangered.

**Likely to become extinct in the foreseeable future.

6. After students have plotted their points, ask them what they think might have caused the strandings in each area. (Actual data are used in this exercise because scientists were able to determine the probable cause of each stranding.) Tell them that the Labrador Current is a cold current that comes from the north. They may infer from the map that the turtles spotted in Cape Cod Bay may have been trapped there by this cold current. On Long Island, cold northwest winds trap the turtles against the shoreline.

7. The leatherbacks on the south shore of Long Island were both found dead along the barrier beach; one had ingested plastic, the other was entangled in a fishing line. Ask students why this might occur at this location. (Proximity to New York City and populated areas. Also, leatherbacks eat jellyfish and may have mistaken plastic for food.) Discuss how important barrier beaches are both as habitat and as protection for the mainland from ocean storms.

The ridleys and loggerhead found along the north shore of Long Island were coldstunned. Explain what this means and describe how the turtles are slowly warmed, given warm liquids intravenously, and then force-fed until they revive. They are kept in tanks until they are healthy again, then they are released, usually with a

tag that enables scientists to monitor their movement by satellite. These turtles were probably driven to shore by the prevailing northwest wind. The other Kemp's ridley and the green sea turtle found in Gardiner's Bay were also coldstunned.

The three coldstunned turtles found in Cape Cod Bay were probably swept into the cold bay and trapped there by the Labrador Current.

S. Ask students to look at Montauk Point, at the eastern end of Long Island. Tell them that the original lighthouse was surveyed and planned by George Washington; it has been moved a few times and just underwent another renovation to protect it. Ask students what the lighthouse needs protection from. They may guess that the erosion around the point has caused a change in the coastline and endangered the site of the lighthouse. Tell them that people who live in Provincetown (the community at the northernmost tip of Cape Cod) periodically "lose" their water wells. Ask for a hypothesis about this phenomenon. There is constant erosion and deposition in this area, which causes the location of groundwater to shift with the shifting sand dunes.

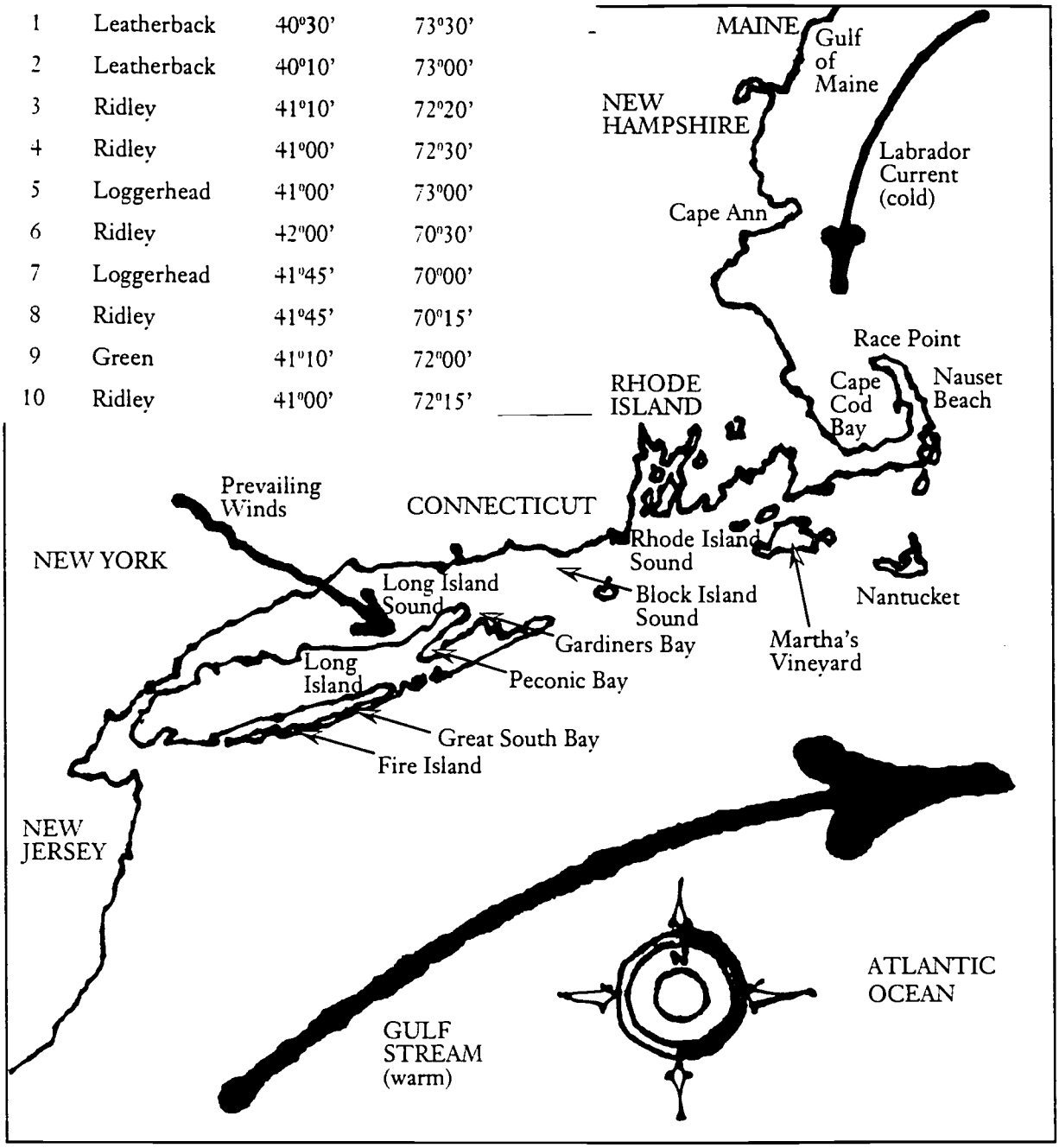
Stranded Along the Coast—*Teacher's answers to stranding table*

Number	Species	Body of water in which found	Diet	Probable cause of stranding
1	Leatherback	Atlantic Ocean near barrier beach	jellyfish	Plastic ingestion
2	Leatherback	Atlantic Ocean near barrier beach	jellyfish	Entanglement in line
3	Ridley	Long Island Sound	crabs	Wind; coldstunned
4	Ridley	Long Island Sound	crabs	Wind; coldstunned
5	Loggerhead	Long Island Sound	crabs	Wind; coldstunned
6	Ridley	East side of Cape Cod Bay	crabs	Current; coldstunned
7	Loggerhead	East side of Cape Cod Bay	crabs	Current; coldstunned
8	Ridley	East side of Cape Cod Bay	crabs	Current; coldstunned
9	Green	Gardiner's Bay, Long Island	vegetation	Wind; coldstunned
10	Ridley	Gardiner's Bay, Long Island	crabs	Wind; coldstunned

Stranded Along the Coast — Student Page A

Stranding Data

#	Species	N. Latitude	W. Longitude
1	Leatherback	40°30'	73°30'
2	Leatherback	40°10'	73°00'
3	Ridley	41°10'	72°20'
4	Ridley	41°00'	72°30'
5	Loggerhead	41°00'	73°00'
6	Ridley	42°00'	70°30'
7	Loggerhead	41°45'	70°00'
8	Ridley	41°45'	70°15'
9	Green	41°10'	72°00'
10	Ridley	41°00'	72°15'



Stranded Along the Coast

Student Page B

Imagine that you are a volunteer at a rescue and release program for stranded marine animals. You get a call that an ocean-dwelling animal has been sighted along a beach. What should you do? Call in the professionals. Experienced scientists who understand the physiology and behavior of marine animals should be the only ones to move or care for a stranded or sick animal. As a volunteer, you would need to know how to give someone the location of the sighting.

Use the Stranding Data table to plot the location of sea turtles that actually were sighted and, when possible, rescued. You will need to approximate the latitude and longitude in some cases. Assume that each turtle was found close to the nearest shoreline. Draw a small turtle icon to represent each in the correct location and write its number on its shell.

After your class discussion, place additional data about the turtles in this table:

Number	*Species*	*Body of water in which found*	*Diet*	*Probable cause of stranding*
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Resources

Online resources

Visit Ocean Planet online at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**

Use the Exhibition Topic Outline to find Fishing Issues and Global Change (under Oceans in Peril). Look under Heroes to learn about some of the people who have worked to protect and preserve the oceans. Click on "Resource Room" to link to other related sites on the Internet such as Turtle Trax, a page dedicated to marine turtles. Also under Resource Room, the Image Catalog offers photographs and illustrations of specific images suggested by the activities in this section.

Resources for students

Tesar, Jenny. *Threatened Oceans*. New York: Facts on File, 1991.

Resources for teachers

America's Seashore Wonderlands. Washington, D.C.: National Geographic Society, 1985.

Stone, Roger D. *The Voyage of the Sanderling: Exploring the Ecology of the Atlantic Coast from Maine to Rio*. New York: Knopf, 1990.

inding it was likely to overblow, we took in our sprit-sail, and stood by to hand the fore-sail; but making foul weather, we looked the guns were all fast, and handed the mizzen. The boat lay very broad off, so we thought it better spooning before the sea, than trying or hulling. We reefed the fore-sail and set him, we hauled aft the fore-sheet; the helm was hard a weather. The boat wore bravely. We belayed the fore-down haul; but the sail was split, and we hauled down the yard, and got the sail into the boat, and unbound all the things clear of it. It was a very fierce storm; the sea broke strange and dangerous.

—*Gulliver's Travels*—Jonathan Swift, 1726.

f you're reading *Gulliver's Travels* or *Moby Dick*, you could be at a loss as to what the narrators are describing if you don't know basic sailing terminology. Our language is peppered (or rather, salted) with expressions derived from life at sea. Thinking of the sea, you may picture whaling boats off Nantucket or Hawaii, warships during the Civil War, or merchant vessels carrying fertilized soil from the tropics to enrich the gardens of wealthy English farmers. However, much of the sailors' jargon that has entered and endured in our language came from the British navy. In the eighteenth and nineteenth centuries, British naval and merchant ships dominated the oceans, developing their own culture with its own customs, practices, and language. n these centuries of global exploration and commerce, boys and men, many of them illiterate, went off to sea and spent years away from home under dangerous conditions. Order and discipline were important in minimizing risk as was communication aboard ship, which had to be crystal clear. For example, different pitches of the boatswain's whistle meant different things: a call for attention, dismissal, or "piping" someone aboard. Shouted instructions often did not carry well against the noise of wind and waves, but voice commands to change the direction of sails had to be carried out immediately, whether to avoid collision with other ships in naval battles, to sail through a typhoon, or to stay on course. Also important to the orderly life of a ship was proper naming, accounting for, stowing of, and using gear. any terms remain in our language as a colorful legacy of the great sailing eras of history. Weekend sailors on the Chesapeake Bay and competitors in the heat of an America's Cup race use the same terms. And what teacher has not tried to get a classroom "shipshape" or commanded, "Pipe down?"

Reflections on the Sea

Objectives

Identify some basic terms associated with boats, ships, and sailing.

Use expressions derived from nautical sayings in context.

Materials

Student Page

Optional: cassette or CD player for music

Subjects

language arts, social studies, literature, music

Procedure

1. Read the selection from *Gulliver's Travels* aloud to students. Ask for student impressions of this almost-foreign language. Help them along by explaining some basic terminology. The main frame of a boat is its *hull*. The *bow* is the forward part of the boat from where the planks begin to curve inward. The *stern* is the wider rear end of the boat. If something is located *aft* it is toward the stern; if it is *fore* it is toward the bow. The *deck* is the planked floor that runs the length of the boat. A *hatch* is a rectangular opening in the deck. You can go *below* into the lower part of the boat, which includes the *hold*, where cargo is stored. The *gangway* is the main entrance to a boat from the side. The *masts* are the tall timbers that carry the sail. The mast closest to the bow is the *foremast*, followed by the *main mast*. If there are three masts, the third is the *mizzenmast*. (Traditionally, a sailing boat with a *bowsprit*—a large, tapered pole extending from the front of the vessel—and three masts was known as a ship. Later, a ship was defined as a boat powered by sail or steam.) Mounted across the masts are large timbers called *yards* that support the *sails*, or *sheets*. The outer part of a yard is called the *yardarm*. The supporting timber of the *foresail* or the jib is the *boom*. The sails are held in place by lines called *rigging*. The *keel* is the structure that runs the length of the boat, supporting and uniting the boat. Most of the keel is below the waterline.

As the wind fills the sails, the part of the boat facing the wind is the *windward* side and the part sheltered from the wind is the *leeward* side. As you look forward on the boat, the lefthand side of the boat is the *port* side and the righthand side is the *starboard* side.

Some other common terms include the following:

fast—secure or fixed

foul—become entangled

list—tilt of a boat

trim—arrangement of sails to get the most wind

limey—During the seventeenth and eighteenth centuries, British seamen were called limeys because of the limes issued to sailors to prevent scurvy.

tack—a boat's direction with respect to the wind

2. Work with your school librarian or music teacher to get a CD or cassette for students to listen to while doing this activity. You might play classical music such as Wagner's *Flying Dutchman* or Debussy's *La Mer*. You might find recordings of traditional sea chanteys—songs sung by sailors in rhythm with their work. The music and lyrics to "Blow the Man Down" and "Sailing, Sailing" can be found in *An Illustrated Treasury of Songs*. You might also find contemporary music that will appeal to students.

3. Hand out the student page. As students work on section A independently, circulate among them to offer help with the meaning of unfamiliar expressions. The Pequod's hull was stained by the typhoons of the Pacific and the calms of the Atlantic, Pacific, Indian, and Arctic oceans. "[D]arkened like a French grenadier" refers to soldiers in Napoleon's eighteenth-century campaigns in Egypt and Siberia who threw grenades in battle and became darkened with soot. The bow—the front of the boat—may have appeared bearded because of seaweed or a protective covering. The masts are the tall timbers that carry the sails,

and the reference is probably to the spires of the cathedral in Cologne, Germany, the most famous example of Romanesque architecture. The wooden decks were probably wrinkled from exposure to seawater.

In section B, students may have answers similar to these:

1. I like the cut of his jib. I like the way he looks—his clothes, his walk. The jib is the triangular sail fore of the foresail.

2. It's time to swab the deck. It's time to clean up. This was the order to clean the boat's deck with a rope mop that sometimes had a wooden handle.

3. Please stand by. This is an expression derived from the command for sailors to be ready.

4. All hands on deck. This expression derived from the captain's command to summon the entire crew.

5. I was really taken aback by what he said. This means to momentarily stop short or literally move back. When the wind suddenly shifts and comes into the sails from the front, the boat is said to be taken aback.

6. It was touch and go there for a while. This expression means you were unsure what the outcome would be. It is used to describe a boat that runs aground and then immediately recovers and floats again.

7. Now everything is on an even keel. Everything is going along smoothly. A boat is on an even keel when the keel is horizontal in the water.

8. Thar she blows. There it is. This was the cry of the spotter aboard a whaling boat upon seeing a whale.

9. In class today, Ms. Smith really lowered the boom. She gave some bad news or got angry. The boom is the timber that holds the jib sail near the bow of a boat. A sudden wind shift can quickly blow it around to knock down anyone standing in the way.

10. It's like flogging a dead horse. This commonly means belaboring a point that has already been made clear. A dead horse is what seamen called a month's work on board, for which they were paid in advance. On the last evening of the month the crew would flog a straw-stuffed horse and throw it overboard.

In section C, encourage students to be creative in writing a scene. For further reading, they might try some of the sea stories from the online *Ocean Planet* exhibit. They might try reading *Moby Dick* by Herman Melville or *Two Years Before the Mast* by Richard Dana. The latter contains a helpful glossary of nautical terms. Some students might enjoy a nonfiction adventure by an oceanographer/innovator such as Jacques Cousteau or Bob Ballard or an adventurer like Thor Heyerdahl.

4. Tell students that sailors can communicate between boats by *semaphore*, a system of visual signaling with flags. Have the students do library research to find out the flag symbols for the letters of the alphabet. Each student can draw and color a page-sized flag to represent a different letter of the alphabet. Place the flags around the classroom for a week or so with the letters labeled. Students can become familiar with their meaning. Then take the flags down and ask students to write out their own names in flag letters. They might create their own flag words and challenge one another to decode them.

Reflections on the Sea
Student Page

What would you be doing if you were on a whaling boat for months at a time? Would you sing a sea chantey or dance the hornpipe? Or would it take you some time to get your sea legs? Perhaps you would write a letter home or create a carving out of a whale's tooth. In this activity, you might get a little closer to what the sailing experience is like.

A. Read this selection from *Moby Dick* by Herman Melville. It is from chapter 16, "The Ship," in which the narrator describes the whaling ship *Pequod*.

> She was a boat of the old school, rather small if anything. . . . Long, seasoned and weather-stained in the typhoons and calms of all four oceans, her old hull's complexion was darkened like a French grenadier's, who has alike fought in Egypt and Siberia. Her venerable bow looked bearded. Her masts—cut somewhere on the coast of Japan, where her original ones were lost overboard in a gale—her masts stood stiffly up like the spines of the three old kings of Cologne. Her ancient decks were worn and wrinkled.

In this selection, Melville describes four parts of the ship. How does he help you picture them in your own mind?

Part of ship	*Description in your own words*
1.	
2.	
3.	
4.	

Reflections on the Sea
Student Page

B. We use nautical expressions in everyday life. Write a sentence to explain what each of the following expressions means in your own words.

1. I like the cut of his jib.

2. It's time to swab the deck.

3. Please stand by.

4. All hands on deck.

5. I was really taken aback by what he said.

6. It was touch and go there for a while.

7. Now everything is on an even keel.

8. Thar she blows!

9. In class today, Ms. Smith really lowered the boom.

10. It's like flogging a dead horse.

C. You may have been listening to some music inspired by the sea. Perhaps you enjoy the ring of nautical expressions. Working cooperatively with a small group, use some of these terms and expressions to write dialogue for a scene of your own creation. Or use them to write some song lyrics to perform for your class.

Resources

Online resources

Visit Ocean Planet online at **http://seawifs.gsfc.nasa.gov/ocean_planet.html**

Using the Exhibition Topic Outline, under Educational Materials go to Sea People Lesson Plan: Words from the Ocean; Ocean Planet Nautical Sayings; Ocean Planet Legends and Customs of the Sea; Baru Bay, Australia; and Ocean Planet: Writings and Images of the Sea. Click on "Sea People" for stories about those who live on and near the oceans. Under the Resource Page, use the Image Catalog to get photographs and illustrations of specific images suggested in the activities in this section.

Resources for students

Dana, Richard. *Two Years Before the Mast*. New York: Viking, 1981.

Resources for teachers

National Gallery of Art. *An Illustrated Treasury of Songs*. New York: Rizzoli, 1991.

Payne, Roger. *Among Whales*. New York: Charles Scribner's Sons, 1995.

The Visual Encyclopedia of Nautical Terms Under Sail. New York: Crown, 1978.

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