# 7 Solutions for Our Ocean

by E. Tucker Hirsch

Most of this guidebook has focused on students' perceptions of the ocean and science phenomena. However, what we leave to the next generation depends upon our actions and understanding of the ocean today. For adults, the ocean can bring out the same wonder and excitement as it does in children, underlining its fascinating characteristics, and importance on our planet. Part of our responsibility to our children is to help them better understand the ocean and all the services it provides to us, and to Earth. While environmental problems in the ocean do happen, and the outcomes of these problems may be uncertain, we do not want to share only the negative impacts humans have on these environments.

Students should understand that people have choices about how they interact with the ocean and that history has shown that people can take measures to protect the ocean. Students should also be aware that they—the next generation of voting citizens—will become the scientists and engineers that find solutions. As citizens, they will choose to make decisions when they vote, and also when they buy products in a store. Students should be empowered to do something to protect our ocean. While they may not be able to vote at the polls or with their own dollars, they will take home what they learn at school and through their parents, they will indeed cast a vote for the ocean if prepared to do so.

This chapter focuses on our relationship with the ocean today and what we are doing to the ocean. The focus then shifts to what the ocean provides us and what we can do—children and adults alike—to ensure the ocean provides for us for generations to come.

## Relationship With the Ocean

The ocean fascinates both adults and children. When exploring tide pools, people are amazed at the diversity of the critters, and many people ask the same

| GRADE | STANDARD | EEI UNIT |
|---|---|---|
| Grade 3 | 3.2.1<br>3.4.1-2<br>3.5.3 | California's Economy—Natural Choices |
| Grade 4 | 4.5.3 | |
| Grade 5 | | |
| Grade 6 | 6.6.b | Energy and Material Resources: Renewable or Not? |
| Grade 7 | | |
| Grade 8 | 8.3.6 | |

basic questions. Where does the hermit crab's shell come from? What eats a sea star? Walking through an aquarium, an adult pauses to take a picture of his teenage son with a ten-foot sand tiger shark in the background. Moments later, a five-year-old points up, mouth agape, and yells, "Look at the big fish!" as the same sand tiger shark swims overhead. It is no wonder that the ocean can engage citizens of any age.

Sometimes we see that children's and adults' knowledge of the ocean does not vary greatly. As we saw in the first chapter, student perceptions of currents, tides, and waves are varied and unclear. Similarly, in *A Private University,* researchers showed that Harvard University graduates are often unclear of the difference in these phenomena, as too are many professional, educated adults. The ocean is vast, and with its sheer size comes the misconceptions that our actions cannot possibly influence such a large system. Could we ever really run out of fish from the ocean? Could coral reefs actually disappear? While children and adults may recognize the negative impacts we have on the ocean, they likely do not realize the severity of these impacts or the urgency for response or may not be aware of actions that can be taken both individually and as a collective citizenry (Belden, Russonello, and Stewart 1999; The Ocean Project 1999).

Many people recognize that we can make choices to support ocean health, but are unsure what to do (The Ocean

## CHAPTER OVERVIEW

**Our lives and livelihoods are intimately connected to the ocean. While prior chapters in this guide have discussed the ocean system and impacts human activities have on that system, this chapter will explore solutions to the ocean issues we currently face.**

**Solutions may include mitigation strategies, such as international, national, or local policies to regulate what humans put into, and take out of, the ocean. Solutions may also include innovative technologies to make human activities more efficient and less harmful to the ocean ecosystem. While governments and large corporations and industries should be involved in these solutions, individual people can take actions to help protect the ocean. Individuals can engage as voters to pass laws to protect our ocean and as consumers to buy products that are sustainable. Even given all these actions, human communities will still need to adapt to changes in our ocean—changes that will affect our everyday way of life.**

**This chapter will explore the range of solutions, including mitigation, innovation, adaptation, and actions that individuals can take. We will take a closer look at actions already taken—where they have succeeded and where they have fallen short—in order to better understand where we must go in the future to protect our ocean.**


**People can make a positive impact on the ocean environment through simple acts such as purchasing sustainable seafood.**

Project, 2009). Do you think about sustainable seafood when you buy fish at your grocery store? Do you think about ocean acidification as you drive your car to work or leave lights on at your home? Do we buy imported shrimp, which is on sale at the grocery store, or choose a more sustainable alternative? These are choices we need to think about each and every day and choices that your students will also be making more and more as they age.

While these issues are urgent and we need an educated citizenry to think more about the ocean, we cannot let "doom and gloom" stories paralyze adults and children from taking action. Science and social-studies educators are uniquely positioned to affect real change among our future voting population. Yes, there is a lack of understanding among children and adults about the ocean. As educators, we not only need to improve understanding of the ocean, but we also need to educate about solutions and actions that have already been taken and can be taken in the future. How can we encourage behaviors that will provide a healthy future for our youth and a healthy future for the ocean?

In this chapter, we will discuss **mitigation** and adaptation techniques for a changing ocean, as well as new, innovative ideas and advances in technology for dealing with ocean issues. We will also look at past and current ocean policies, where these policies fall short, what beneficial changes came about through the policies, and what these actions tells us about future solutions.

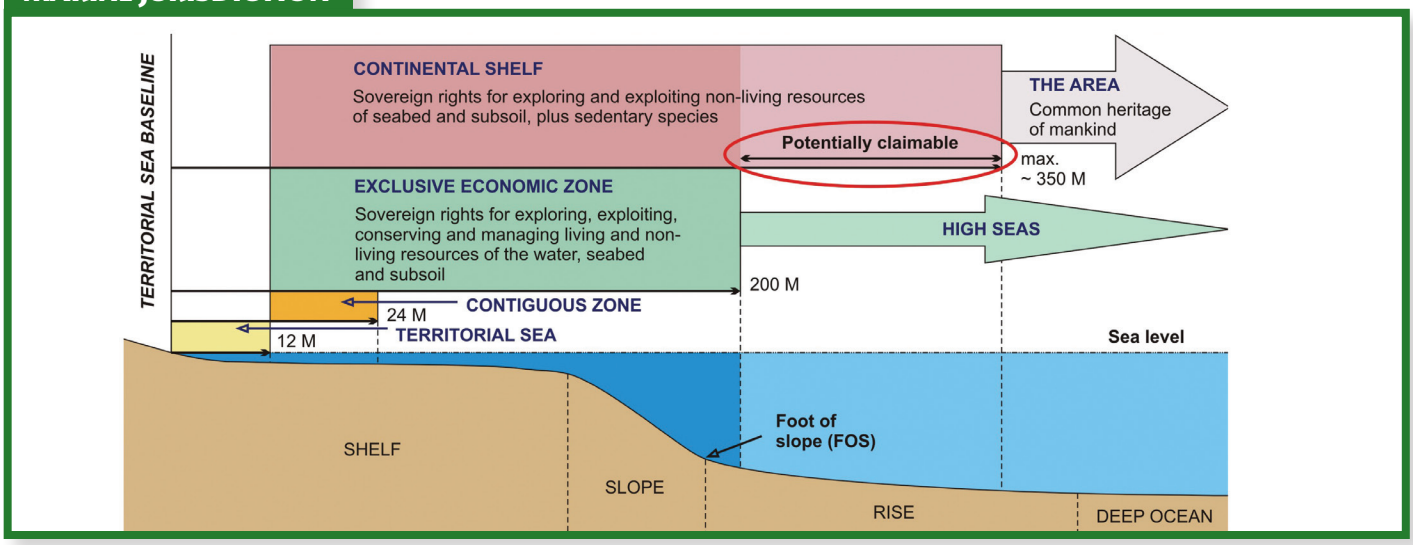
## Who Protects the Ocean?

Once considered the "high seas," the open ocean was a place of piracy, warfare, and uncharted waters with land to explore and discover. It is only relatively recently that countries have been making more claims on and, therefore, are having greater impacts on, the ocean. Students may not even know that countries own parts of the ocean. So why is it so difficult to simply make a law that protects the ocean? One drawback is that international law is not set in stone and can be hard to pass in the first place. Nationally, different states have different regulations, and municipalities within a state may have varying regulations. Following is an introduction to the different ruling agencies and bodies that can lay claim to and protect the ocean.

**The Law of the Sea.** The UN Nations Convention on the Law of the Sea is the treaty that establishes international law for the sea beyond national territories. In 1994, after the sixtieth country ratified the treaty, it went into effect. Prior to the Law of the Sea, the open ocean was considered the high seas and was owned by no country but was free for all countries to utilize. Slowly, individual countries started to take an interest in the resources available in the ocean and began to extend their territorial bounds to include larger swatches of the ocean adjacent to their coastline. As claims and interest grew, it became evident to the international community that there was a great need to regulate the use of ocean resources, both for the protection of the ocean, and for fairness to the countries with smaller or no coastlines.

**Helping to protect the ocean and its beaches is everyone's responsibility.**

## MARINE JURISDICTION




**The Law of the Sea and other laws specify rules and regulations to govern how humans interact with the ocean. For example, 321 kilometers (200 miles) from the coastline is the Exclusive Economic Zone. Each nation has exclusive rights to resources within this area. Courtesy of Federal Institute for Geosciences and Natural Resources (BGR). Adapted from Symonds et al. 1998)**

The Law of the Sea established, among other items, an **exclusive economic zone** (EEZ) for countries, extending to 320 kilometers (200 miles) from a country's coast, within which a nation may take resources from the ocean but other countries may not without consent. The Law of the Sea also established rules and regulations for scientific research in and on the ocean, seabed exploration, and mining policies as well as traffic and transit regulations. This law was implemented by a variety of international organizations, such as the International Whaling Commission and the International Maritime Organization.

The Law of the Sea, with its large scope and strong international policies, is wonderful in that it is widely accepted. More than 150 countries have ratified the Law of the Sea, signifying an accord among the international community. The caveat with international policies is that they have little or no official standing and can be difficult to enforce. One country cannot simply sue another country for violation of the law. Countries can be brought to international court, but on a basic level, they must be invited, and offenders must accept. It is extremely difficult to monitor and enforce international laws—politically, logistically, and economically. Finally, international laws are not mandatory nor are they necessarily binding. The United States has signed, but not ratified, the Law of the Sea.

Other international regulations exist to help regulate ocean activity. For example, MARPOL (short for marine pollution), or International Convention for the Prevention of Pollution From Ships, was a monumental international regulation passed in the 1970s to help protect the ocean from **abiotic pollutants,** as well as introduced species. The International Convention for the Regulation of Whaling and its ruling body, The International Whaling Commission (IWC), were established in the mid-20th century to ensure the health of whale populations worldwide. The Migratory Bird Treaty Act of 1918 helps to protect waterfowl—many of which are seabirds that migrate through the territories of different countries—by making the taking, death, sale, or transport of them illegal.

These are just a handful of historically monumental international laws to protect and preside over the ocean. Countries and even individual states or regions can also have their own **jurisprudence,** so have your students explore their state and local regulations.

## Teaching Tip

Using maps of local or nearby coastlines, have students explore how far off shore the United States actually extends. See if they can measure the 321 kilometers (200 miles) of the exclusive economic zone. For comparison, can they measure the 4.8 kilometers (3 miles) offshore that each state is responsible for?

**Many state, national, and international organizations manage ocean resources, such as oil and wildlife.**

**The United States: Alphabet Soup.** In the United States, there are many different agencies tasked with the care and protection of our ocean. Almost every activity occurring on, in, adjacent to, or in someway connected to the ocean requires a permit or license, and many activities require the signature of more than one agency.

For example, offshore oil drilling, and other abiotic **natural resource exploitation,** is under the jurisdiction of the Bureau of Ocean Energy Management (BOEM), the Bureau of Safety and Environmental Enforcement, and the Office of Natural Resources Revenue, all of which are part of the U.S. Department of the Interior. However, the oil drilling, platform, refinement, and transport must conform to the regulations established by the Environmental Protection Agency (EPA). New projects planned for national waters must be acceptable under the National Environmental Protection Act (NEPA), administered by the Council for Environmental Quality (CEQ), and only after an Environmental Impact Statement (EIS) is written. The process is often bypassed in the name of national security, and projects performed by the Department of Defense (DoD), such as testing submarines in the Channel Islands, California, in marine mammal habitat, may be exempt from completing an EIS.

The point of this example is to convey the difficulty of regulating a wide variety of activities in a vast area. However, regulations do exist that work, most often effectively, to protect our ocean nationally. Some examples include

- The Endangered Species Act—Passed in 1973, it protects those species at risk of extinction due to activities related to economic growth and development. It sets rules and regulations regarding impacting those species and requires plans to be developed that will help their populations to recover.
- The Marine Mammal Protection Act—Passed in 1972, the MMPA makes it illegal to take (harass, capture, hunt, or kill), import, export, or sell a marine mammal or any part of a marine mammal in the United States or in its waters. U.S. citizens can be held accountable for breaking this law while outside of the United States as well.
- The Ocean Dumping Act—Passed in 1988, effective January 1, 1992, this act prohibits all dumping of municipal

## Explore More

For more information on these acts, visit the following resources:

- The Endangered Species Act: http://www.nmfs.noaa.gov/pr/laws/esa/
- The Marine Mammal Protection Act: http://www.nmfs.noaa.gov/pr/laws/mmpa/
- The Ocean Dumping Act: www.epa.gov/lawsregs/laws/mprsa.html
- The Magnuson Stevens Fishery Conservation and Management Act: http://www.nmfs.noaa.gov/sfa/magact/
- The Oil Pollution Act: http://www.epa.gov/oem/content/lawsregs/opaover.htm

**The continued survival of the brown pelican (Pelecanus occidentalis) was at risk in the 1970's due to DDT use. Protection by both the Migratory Bird Act Treaty of 1918 and the Endangered Species Act of 1973 helped the species recover, but this species is still threatened by human impacts, like oil spills.**

sewage sludge and industrial waste into the ocean.

- The Magnuson-Stevens Fishery Conservation and Management Act—Originally passed in 1976, this act created laws and national policy requiring an integrated fisheries management.
- The Oil Pollution Act—Passed in 1990 in response to the Exxon Valdez Spill of the previous year, this act created laws that require companies involved with oil and the ocean to have comprehensive plans to prevent oil spills and detailed containment and cleanup plans should a spill occur.

Any of these laws may be good examples to discuss with your students. In addition to these, both the Clean Air Act and Clean Water Act are very important to keeping our ocean clean and healthy. The Clean Air Act limits the amount of air pollution allowed in an area. Suspended particles and chemicals that commonly make up air pollution make their way to the ocean as precipitation picks them up and carries them through the water cycle. The Clean Water Act protects waters from point-source pollution (see Chapter 5) and also from nonpoint-source pollution by holding local governments accountable for dumping from their communities. The Clean Water Act considers storm-water runoff as point-source pollution but agricultural runoff as nonpoint-source pollution.

It should be noted that the U.S. Coast Guard is the major agency charged with ensuring maritime safety, security, and stewardship. Along with the U.S. Navy, the U.S. Coast Guard is in charge of ensuring maritime law enforcement in both domestic and international waters. These two agencies are the enforcers for most, though not all, marine-related laws in U.S. federal waters. Two other federal agencies that play a major role in the protection of the marine environment and enforcement of laws relating to them are

- The U.S. Fish and Wildlife Service—A bureau within the U.S. Department of the Interior, it is the major agency tasked with taking care of U.S. natural living resources, including fish, wildlife, and habitats.
- The National Oceanic and Atmospheric Administration—NOAA is a scientific agency within the U.S. Department of Commerce; the agency that predicts and tracks weather, ocean conditions, and overall climatological trends, is responsible for ensuring the sustainable use of marine and coastal resources; the National Marine Fisheries Service is a branch of NOAA.

It is easy to see how, with so many different agencies and organizations involved, the stewardship and conservation of our marine resources can be difficult. On the other hand, with so many different groups involved, it is hoped that one of them will always be there to make sure the ocean is protected. Because of the number of

## Teaching Tip

Students often have a hard time relating to legislation, as it seems so disconnected from their day-to-day lives. The next time you have students research an animal or plant, have them expand their research to see if that organism is protected by any state or federal laws as well. Understanding the laws and how they might impact an organism they care about can help make the organism more real and comprehensible for students.

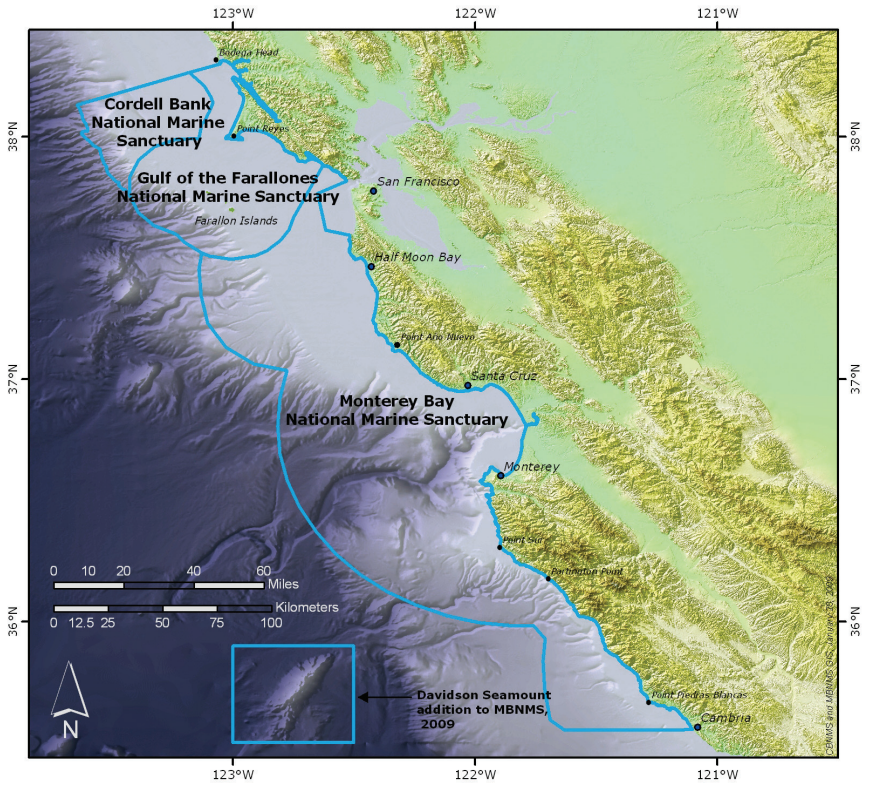
organizations, it is important to talk about the roles of each of these groups with your students.

**Marine Sanctuaries.** In the 1970's, scientists and citizens alike began to recognize that many of our natural resources were at risk. This lead to the passing of many of the acts already mentioned. It also led to the passage of the 1972 Marine Protection, Research and Sanctuaries Act, which allows for the creation of national **marine sanctuaries** in areas of special conservation, recreational, ecological, historical, research, educational, or aesthetic resources. For the first time, an entire habitat or ecosystem was protected, along with all the organisms that call it home. The Secretary of the Department of Commerce can create these marine sanctuaries, or the president can establish a special marine protected area known as a Marine National Monument. There are National Marine Sanctuaries and Marine National Monuments in diverse places throughout U.S. territories, including in the Great Lakes, Florida Keys, Gulf of Mexico, and American Samoa. The largest marine protected area in the National Marine Sanctuary System is the Papahanumokuakea Marine National Monument in the northwest Hawaiian Islands. California is home to four National Marine Sanctuaries: Channel Islands, Monterey Bay, Cordell Bank, and Gulf of the Farallones.

**Fisheries Management.** The commercial fishing industry started its boom around the beginning of the 20th century, and individual states started managing fisheries around the same time. In California, the task fell upon the shoulders of the California Department of Fish and Game. Many of the early regulations had the same targets as present-day regulations: prohibition from catching certain species, seasonal openings based on spawning, limitations on the size, sex, or age of a fish, catch-method limitation, net-size minimum limits, and, in some instances cordoning off areas altogether.

Later, fisheries management began to evolve around the same time that the country was discovering environmentalism. In 1976, shortly after the fall of the Pacific mackerel fishery, the Magnuson-Stevens Act transformed fisheries management to focus on actual data from the fish stock itself, rather than setting arbitrary limits. The federal act required national and regional fishery

## MARINE SANCTUARIES IN CALIFORNIA




**Marine sanctuaries include ocean gardens, coastal coral reefs, whale-migration corridors, deep-sea canyons, and even underwater archeological sites.**

**Fisheries must comply with state and federal policies regarding seasons, catch limits, catch sizes, and so on.**

management plans created by regional groups in order to protect the future of fish stocks. In 1996, the Magnuson-Stevens Act was amended to include the Sustainable Fisheries Act, which shifted the focus of fisheries management to conservation and sustainable practices, from the previous practice of trying to manage the fishery in such a way that maximized catches, year after year.

Only recently have fisheries managers considered both recreational and commercial fishers together when drafting management plans. For years, the two fishing sectors blamed each other for increased competition of fish stocks, for being at fault for depleting certain populations, and for decreasing water quality. In some cases, science and collection data can point to either recreational or commercial fisheries as the cause for the crash of a fishery, but more often many other facts, including habitat destruction and polluted runoff into the ocean, are responsible for declines in fish stocks. Management of commercial and recreational fisheries in California resides with many state and federal organizations including NOAA's National Marine Fisheries Service (through the regional fishery management councils) and the Department of Fish and Game. All agencies must now work together to create comprehensive and integrated fisheries management plans. Newer management strategies include **individual transferable quotas** (ITQs). ITQs can be sold or traded as long as they are below the set quota ceiling. Fisheries, managers set a total allowable catch (TAC), and then fishers can buy and sell their shares.

**State Jurisdiction: California Coastal Commission.** Many states delegate a government committee to oversea marine affairs, regulations, and policies. In California, the Coastal Initiative established the Coastal Commission in 1972. In 1976, the Coastal Act made the committee a permanent establishment. Because states only have jurisdiction up to 5.5 kilometers (3 nautical miles) offshore, a lot of the focus of states' ocean committees is on coastal-zone management. The goal of the California Coastal Commission (CCC) is to conserve and restore California's coast for the enjoyment of citizens and visitors and for the health of the ecosystem. With some specific exceptions, any new development along the coast that would impact the coastal system must receive a permit from the Coastal Commission. New buildings along the state's beaches must be approved, as well as, for example, a new parking lot adjacent to a wetland that connects to the coast.

**Fishing boats docked in Puerto Penasco, Mexico.**

The Coastal Commission is also responsible for maintaining access to the beach for the general public. In the 1987 landmark court case, *Nolan v. the California Coastal Commission,* the U.S. Supreme Court ruled that the state may forcibly buy property, via eminent domain, to maintain easement to the beach for public beachgoers. This ruling underlines the value we place on our coasts for our enjoyment as well as our livelihood.

**The California Coastal Commission is one of the many agencies responsible for keeping California's coasts safe for future generations.**

Case Study

# The Recovery of the California Brown Pelican

Sitting on a California beach, you see a flock of birds flying just above the cresting waves in perfect V-formation. As they scan the waters below for fish, the leader glides upward, then turns and dives into the surf below. In quick succession, the rest of the flock shoots into the water, resurfacing moments later.

In what might have been an uncommon sight only a few decades ago, these birds, the California subspecies of the brown pelican *(Pelecanus occidentalis californicus),* have recovered from the brink of extinction.

Their success story is tied to the life and work of one of nature's most passionate protectors, biologist Rachel Carson.

In the 1940s and 1950s, scientists thought they had finally found the solution to one of the biggest problems to plague humanity—mosquitoes. The insect with the incessant buzz does more than just annoy you and leave the occasional itchy red bump on your arm. Mosquitoes and other insects carry diseases, including malaria, that cripple and kill thousands of people every year. Other insects kill crops and devastate agricultural yields. Chemical advances in the early 20th century provided new and powerful insecticides to battle against these pests.

One insecticide widely used on everything from forests to parks, beaches to bedrooms, was DDT (dichlorodiphenyltrichloroethane). DDT was purported to be safe, without any side effects. Over time, its claim of safety was shown to be untrue. DDT bioaccumulates, or builds up, in the fatty tissues of creatures that come into contact with it, either in their environment or their food.

As it progresses up the food chain, DDT biomagnifies, resulting in higher predators having greater amounts of the chemical in their tissues. In birds, in particular, this biomagnification has dire consequences. It causes a thinning of eggshells. Parent birds actually crush their eggs while incubating them.

The loss of songbirds and other species was brought to the attention of Carson, who had worked for the U.S. Fish and Wildlife Service. She was upset about this phenomenon and motivated to inform the public about what was happening to our wildlife.

With the 1962 publication of Carson's book *Silent Spring,* the issue of thinning eggshells and the loss of birds was brought to the attention of the public in a major way.

Larry Schweiger, the president and CEO of the National Wildlife Federation, believes Carson's work was a turning point for birds, including the brown pelican.

"My personal view is that Rachel Carson's book really woke up the public to what scientists had been saying for some time and that was the decline of certain bird species including the California brown pelican," he says.

Schweiger says *Silent Spring* helped influence the creation of the Environmental Protection Agency in 1970, the ban on DDT in 1972, and the Endangered Species Act in 1973. The Endangered Species Act ordered the creation of a Species Recovery Plan and extreme protection of any species listed. The brown pelican was one of the first species to be protected.

"What [Carson] did do was she sparked an awakening that swept across America, and that awakening triggered an upwelling that really took several years after her death [in 1964] to come to fruition," Schweiger says.

As a result of the DDT ban, careful species management, and protection, the brown pelican has recovered. In 2009, the U.S. Fish and Wildlife Service removed the brown pelican from the federal list of endangered species, and the California Fish and Game Commission removed the subspecies from the state's list.

Today, the U.S. Fish and Wildlife Service estimates that 650,000 brown pelicans exist globally, and a healthy breeding population of more than 140,000 birds thrives along the Pacific coast.

Case Study

# The Gray Whale: Past, Present, and Future

The gray whale is the official California marine mammal, having edged out the sea otter for the position in 1976. There were once three stocks of gray whales—one in the Atlantic Ocean, long extinct; one in the western Pacific; and a third in the eastern Pacific.

The species makes well-documented seasonal migrations north and south along the state's coast and beyond, from the warm, shallow waters of Mexico to the nutrient-rich waters of Alaska. During their 19,300-kilometer (12,000-mile) journey, gray whales are often spotted from shore, making them a favorite of whale-watching companies. They are easily identified by their dark gray color, lumpy back, heart-shaped spout, and absent dorsal fin. They grow up to 15 meters (49 feet) long.

Gray whales are known to feed on at least 85 different species. They specialize in bottom feeding, focusing on amphipods—small, shrimp-like organisms that live in tube structures in mud. They also ingest other mud-dwelling invertebrates, including tube worms and mollusks.

To feed on these creatures, whales suck in water and mud and separate food morsels using their broom-like baleen plates. They then push the excess water and mud back into the ocean by using their tongue to scrape food from the baleen.

As bottom feeders, gray whales prefer shallow waters and, therefore, migrate near the coast. Mothers birth one calf at a time, nursing them in the warm, shallow waters near Baja California, Mexico.

Unfortunately, some of these characteristics of gray whales nearly led to their demise.

Alisa Schulman-Janiger is the gray whale census director for the Los Angeles, California, chapter of the American Cetacean Society. She says the hunting of gray whales in Baja California lagoons during the late 1800s and early 1900s was devastating.

"The single biggest thing is that gray whales were targeted in their nursing lagoons," she says. "So the whalers would go into the lagoons and kill the pregnant mothers, the nursing mothers, and the calves would die also."

Eastern Pacific gray whales were hunted to near extinction in the mid-1800s and again in the early 1900s. Their blubber produced oil used for lamps. The animals were easily accessible to whalers because they remained close to the coast. The species became overhunted in southern California and Mexico. As populations rebounded in the 1920s, whalers used "floating factories" to process the whales out at sea.

Today, Pacific gray whales are protected by international organizations and several government agencies. The International Whaling Commission (IWC) was established in 1946 to regulate whaling throughout the world's oceans. Gray whales received protections from the IWC in 1947. In the United States, the animals are further protected by the Marine Mammal Protection Act and Endangered Species Act. Mexico transformed some of Baja California's major breeding and nursing lagoons into a protected refuge zone.

Limited whaling is still practiced by indigenous peoples in Alaska, Canada, and Mexico. There have also been some reports of illegal whaling by nations that do not accept IWC treaties.

After being near extinction in the 1950s, the gray whale population in the eastern Pacific has rebounded to an estimated 19,000 animals—considered to be a healthy stock. In 1994, the gray whale was "de-listed," or removed from the Endangered Species List.

Unfortunately, gray whales in the western Pacific, vulnerable to whalers from Japan and Russia, have not fared as well—their population remains at just less than 100 animals.

"The steps that they [the IWC] took in the case of the western gray whale mostly weren't taken soon enough," Schulman-Janiger says. "For the eastern Pacific gray whales, those steps plus other laws that were passed by the United States to protect them along their migratory route has really, really helped tremendously."

**Habitats within an MPA are healthier and more diverse.**

**California and Its Regional Coast: Marine Protected Areas (MPAs).** Over time, people have recognized that our haphazard and uncoordinated attempts to protect species or habitats have been unsuccessful, or less successful than we had hoped. A new paradigm for conservation has taken hold over the past 20 years or so and that is one of creating coordinated areas that are protected, conserving delicate species and habitats together. Scientists have also discovered that, if you cannot protect an entire area, protecting a series of small patches within the bigger area can help. Deciding how to delineate these areas can no longer be arbitrary as well—the how and the why for protecting an area or a series of areas needs to be based upon scientific knowledge.

On land, the data and studies are being used to better create parks. While underwater, they are being used to create Marine Protected Areas, or MPAs. Marine Protected Areas are regions in the ocean that are protected at a variety of different levels, including some National Marine Sanctuaries and Marine National Monuments described on page 122. Some MPAs, usually called Marine Reserves, are the strictest kind and are no-take zones prohibiting the take or removal of any items, whether they be sea stars or clams by beachgoers or fish by fishers. Some Marine Protected Areas limit take by species or by commercial fishing or sportsfishing. In most MPAs, kayaking, surfing, swimming, SCUBA diving, and boating are permitted.

In areas where MPAs have been created, studies tend to show that the ecosystem approach of protection is very effective, especially when no-take zones are a part of the model. In protecting the whole habitat, all organisms in the area are given the opportunity to return to normal, healthy populations. Because all organisms are linked to others within their habitat, protecting the entire ecosystem has been more effective in protecting threatened or endangered species than those efforts that focused on the species alone. As a result, overall biodiversity increases in MPAs. Also, in MPAs, especially in Marine Reserves, individual organisms are able to grow much larger than they can outside of protected zones. This is important for fish because large females are able to produce more eggs and, therefore, more young than smaller females, thereby helping populations of fish species increase. As the population grows, areas outside of the MPA see a spillover effect, which occurs when the overcrowded population leaves the MPA in search of more food or an unoccupied territory; therefore, MPAs can help protect and improve more than just the area covered.

In the United States, the National Marine Sanctuaries are a type of MPA being used to protect the ocean but were designated with different goals than those of the Marine Life Protection Act (MLPA). The National Marine Sanctuaries program is run and financed by the federal government under the auspices of NOAA. The program is concerned with classifying waters that touch either U.S. soil, or the soil of U.S. interests, as marine reserves. Alternatively, the Marine Life Protection Act is a California state law and is, therefore, funded by the state. This law mandated a reorganization of the protected areas along California's coast and the waters that touch its soil—as a result, some of these areas are labeled as reserves, while others are classified differently. Through the passage of the Marine Life Protection Act in 1999, the state of California began the process of creating a comprehensive network of MPAs along the coast using scientific data to help determine the placement and size of MPAs. The California-coast network of MPAs was completed in 2012. The process of creating the network of MPAs involved scientists, government agencies, fishers, environmental groups, divers, kayakers, and other concerned citizens. The end result is a system of MPAs from the Oregon border to the Mexico border, protecting delicate habitats and the numerous species that call the California coast home.

Student Thinking

# Protecting Our Ocean

When students are asked about what they can do to protect the ocean, a teacher may get a list of answers such as the ones shown in **In the Classroom: Solutions From People**, page 135. Some of these solutions require obvious actions that even young children can understand and practice. For example, "don't litter" and "obey fishing rules" are obvious solutions. But not all the solutions are straightforward. What about solutions such as, "don't spill oil anymore." This solution requires actions that students may not be able to identify readily. Oil drilling is driven by widespread need for oil-based products such as gasoline and plastics. Our society cannot simply stop drilling for oil. This solution requires reducing energy use, carpooling, bicycling, buying fuel-efficient cars, electing political leaders that will support alternative energies, and so on. Unlocking solutions such as this one will require additional instructional time compared to more obvious solutions that students may mention.

## Scenario

Your students have just returned from an assembly in the school about how they can be stewards for the environment, especially the ocean. You ask students what they learned during the presentation and receive the following answers.

## Question

What can you do to protect the ocean?

## Scientific Answer

People can follow the four *R*'s: Reduce, Reuse, Recycle and Rot (see **Actions: Protecting Our Ocean Everyday,** page 132) to guide their everyday actions. Being smart consumers is important, especially reducing consumption of products that harm the ocean (e.g., unsustainable seafood, plastics, such as plastic bags and packaging).

## Student Answers

**Kate:** We need to stop polluting! That will kill animals. We need to wash our cars on the grass so it doesn't go in the gutter and not leave trash on the ground. Leave nothing on the beach that can be harmful.

**Bridger:** What I can do is stop littering because the water running around can swift the litter into a drain and go into the ocean.

**Tamara:** What I can do make sure oil doesn't get in the streams.

**Reagan:** I can help adults tell people what and where you can fish, so the food chain stays balanced, and they all [all the organisms] stay healthier.

## What Would You Do?

1. Although all these answers are correct, they are not very complex. How would you guide the rest of this class discussion to elicit more sophisticated answers from your students?
2. How could you make sure students can identify large-scale efforts in marine conservation, while still emphasizing the practical and useful actions they can take as young citizens?

Pictures of Practice

# The Aquarium Trade

As consumers, we make many choices about the products we buy. We make choices whether to spend more to get exactly what we want or whether to buy more affordable options. Sometimes these choices support large-scale industries that harm the environment, and sometimes the choices support industries or small-scale businesses that engage in sustainable practices. With respect to ocean products, one of the most obvious decisions consumers make is the choice about purchasing seafood. Given the wealth of attention devoted to this issue and the websites and resources made available to help in this decision-making (i.e., Seafood Watch guides, and so on.), right and wrong choices about seafood are easier to make. But what about choices regarding jewelry, decorations, and pets that come from the ocean?

**Students: Grade 7**

**Location: Carpinteria, California (a coastal community)**

**Goal of Video: The purpose of this video is to see students learn about and discuss the trade-offs of the aquarium trade and whether this trade is good or bad.**

## Classroom Context

Previously, Ms. West taught a series of lessons on coral reefs to her students. Although her students live in a costal community, coral reefs are not a habitat close to home. Students studied coral reefs located in Oceania and learned about historical and modern-day resources we get from coral reefs.

## Video Analysis

During Ms. West's lesson, she starts a class discussion about what people get from coral reefs. Jacob brings up jewelry, decorations, and aquarium fish. This question leads to a discussion of the aquarium trade and buying other marine products and whether these purchases are good or bad. The aquarium trade is an industry that involves international trading of live marine organisms, including fish and corals. Millions of marine organisms are captured and traded each year. Most of these organisms come from reefs in Southeast Asia, and up to half of the buyers are from the United States. Fishers in poor communities are attracted to the aquarium trade because it can be a relatively lucrative business compared to fishing. It is also an industry that is unregulated. In the United States, the Marine Aquarium Council has developed a voluntary system for certification that can help label products as eco-friendly, but this system is not widely used. The UN Environment Programme (UNEP) also maintains an information website on the trade of marine species (http://www.unep-wcmc.org/biodiversity-series-17_108.html). Although students did not go into great depth regarding this industry, they completed short small-group and whole-group discussions about whether this industry is good or bad. You will hear students describe that taking live animals is acceptable, but taking live animals and killing them for decorations is not acceptable. One student proposes artificial replicas of marine organisms.

## Reflect

### How would you teach a controversial ocean topic to your students?

Remember, some students may be consumers of aquarium trade products, such as owning a tropical fish tank. How would you address potentially controversial topics in your classroom, including conclusions that may contradict student practices outside of school, such as owning fish tanks and buying unsustainable seafood? Which topics would you teach and why?

## Innovation: New Ways of Interacting With the Ocean

As available technology advances, we are finding more ways that the ocean can provide for society, as well as new ways that we can live that decrease the stress on the ocean. The ocean has many solutions to help us meet our need and demand for energy. However, when considering renewable energy sources, we must remember that all alternatives, such as traditional nonrenewable sources, have advantages and disadvantages. An alternative energy source must be economically and technologically feasible, socially and politically acceptable, and environmentally sound for the long run.

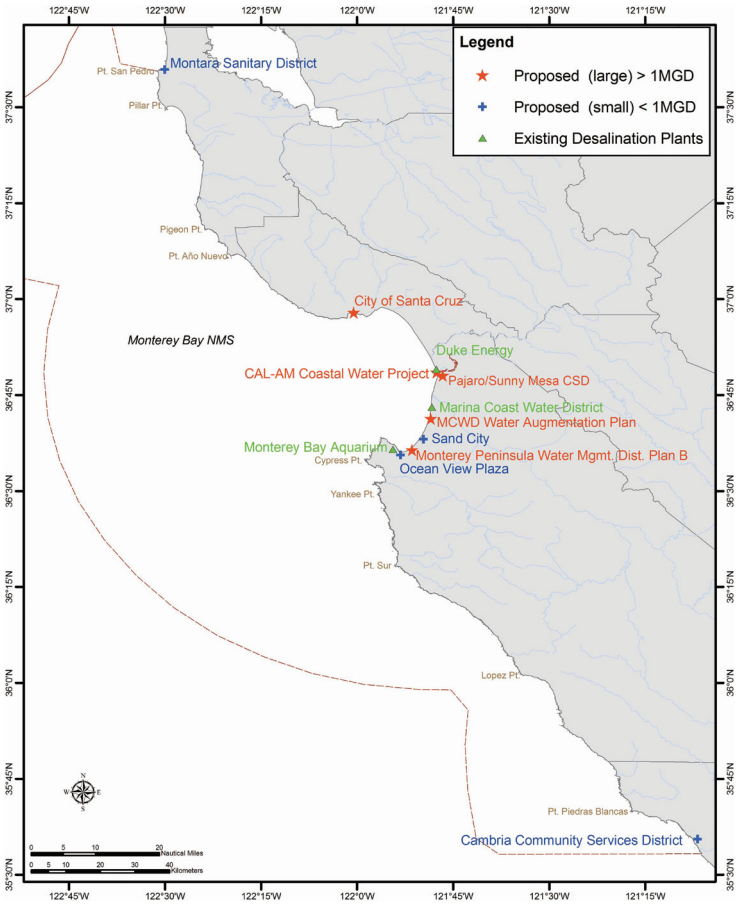
### Desalination and Power Plants.

In the *Rime of the Ancient Mariner,* Samuel Coleridge's character remarked of the ocean, "water water everywhere and not a drop to drink." Less than 1 percent of all freshwater on Earth is available to humans for drinking, showering, and other everyday use. Fortunately, we are now able to utilize the ocean's salt water for freshwater uses, through the **desalination** process. Removing salt from ocean water provides freshwater for human consumption and for irrigation. However, there are many environmental drawbacks to desalination that you may want to discuss with your students. One downside to desalination is the intake of organisms with the water being brought into the desalination plant. Many organisms, large and small, can be sucked into the pipes that bring water into the plant, or caught in the screens meant to keep them out—this is called **entrapment.** Another downside is that removing salt and minerals from ocean water requires large amounts of energy and produces the waste of those salts and minerals. Some of the salts and minerals may be utilized (as table salt, for example), but they are often dumped back into the ocean, creating an area of higher-than-normal salt concentration called brine. As discussed in previous chapters, many organisms have specific salinity requirements, and changing the salinity can affect their chances of survival. Furthermore, the process of desalination is energy intensive. This energy use contributes to GHG emissions, and while it may provide more water, contributing to climate change could make water scarcity an even bigger problem on an even larger scale.

In the past, desalination plants were sometimes coupled with an existing power plant. As the plant brought in water to cool the generators or reactors, the water was transferred to the desalination plant. Nowadays, these two systems are less likely to be coupled. California, for example, is phasing out "once-through power plants" because of the Clean Water Act. Once-through power plants try to reuse water repeatedly to cool their generators or reactors. Desalination plants are now being built on their own.

Some people worry that expansion of desalination plants in California and other coastal areas will lead to two major problems—killing ocean wildlife during the pumping process and changing the marine environment when brine is discharged. However, the benefits of desalination would be protection of freshwater resources and the wildlife that live in aquatic habitats, as well as developing plans for future water security.

**PROPOSED DESALINATION PLANTS AROUND MONTEREY BAY**




**Three desalination plants already exist in this region of California, but several more are proposed for future consideration.**

There are a variety of techniques used for desalination, including vaccum distillation, multistage flash distillation, and **reverse osmosis.** Vacuum distillation is when a facility boils salt water at a low atmospheric pressure, which means the water boils at lower temperatures. In this method, less energy is required. Multistage flash distillation, a widely used method, removes salt and minerals by turning water into steam throughout a series of heat exchangers. The steam is then collected and cooled. Reverse osmosis is another popular desalination method that filters water by applying pressure to one side of a membrane, using the membrane to remove larger particles. Many of these techniques are energy intensive.

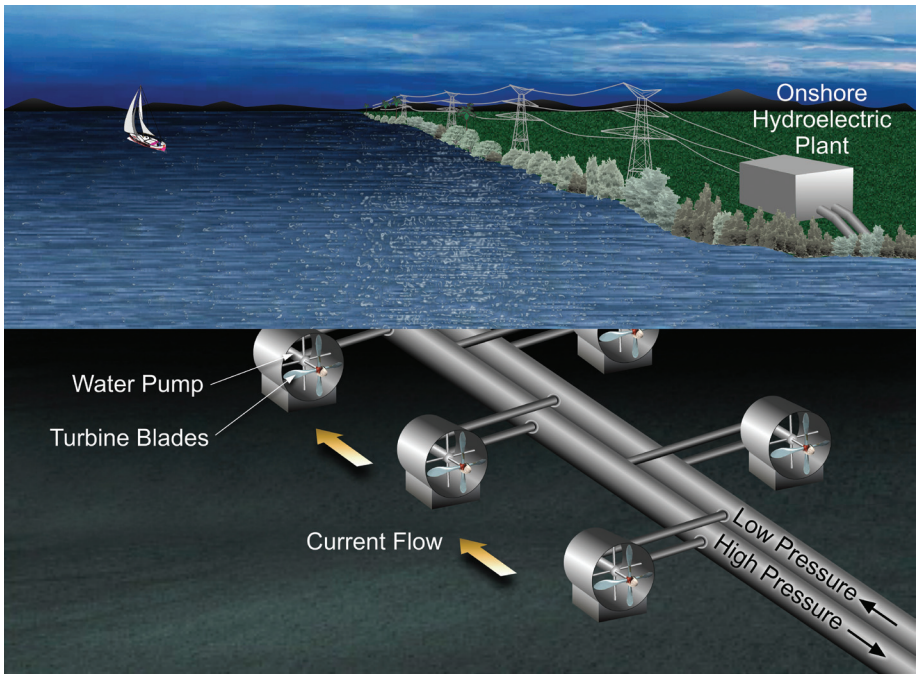
Research is ongoing for alternative methods that require less energy, increase water output, and decrease environmental impact. Some scientists are looking at natural systems for inspiration on methods of desalination. As mentioned in Chapter 2, as water infiltrates, or percolates, through layers of soil, it is cleaned. The water moves on its own, with no need for power. The possibility of creating a desalination plant that mimics infiltration on a large scale is one that scientists are currently exploring. All of these, methods, however, still involve the entrapment of marine life when water is brought in. Until this issue is overcome, desalination still impacts the ocean in a very negative way. The best way to create water is to conserve it, reducing or eliminating the need for such involved and intensive procedures.

**Wave and Tidal Energy.** Humans have utilized water's power for centuries. The earliest of these technologies was in the form of a water wheel to help grind grain, move paddleboats, and perform other preindustrial processes. Dams have provided huge sources of hydroelectric power. Recently, scientists and engineers have begun planning for wave-and-tidal–energy facilities. These facilities would provide electricity from the natural surges in the ocean. While the practice of harnessing energy in this manner is in its infancy, the Federal Energy Regulatory Committee has started issuing preliminary, three-year wave-energy permits. These permits are part of the testing of wave and tidal energy: and FERC, scientists, and private energy companies are working together to make the most out of the new technology. Early implementation and tests are showing promising results with these systems.

Wave- and tidal-energy is a clean, renewable source of energy with no by-products and a relatively consistent source. However, environmentalists are concerned about the impact on marine animals and the environment. New construction, whether offshore or coastal, could change animals' habitats and migration patterns, similar to the impact of dams on salmon. Tidal-and-wave-energy units can be large and unseemly, marring coastlines, which can make them unpopular with nearby residents and in communities whose economy is based on having a scenic coastline. Furthermore, the energy must be transferred from the coast or ocean to the preexisting electrical grid. As energy is moved, some of it is lost. The farther the energy is transferred, the more energy is lost by the time it reaches its destination.

**Wind Energy.** Wind energy is most effective when there is a lot of consistently blowing wind. The ocean meets this criteria because in some areas the wind will constantly and

**A contra-rotating marine turbine is ready to be installed.**




**The movement of water causes the underwater turbine blades to rotate, which send high-pressured fluid to turn turbines in an onshore hydroelectric power plant.**

predictably blow for weeks. Wind energy is another clean, renewable resource. Scientists and engineers have been building wind turbines for decades and transferring the energy to the electrical grid. However, wind turbines in the ocean are relatively new.

Environmentalists, scientists, engineers, and energy companies are trying to find a balance between wind energy and the environment. The energy must be transported to the electrical grid, and, the farther offshore the turbines are, the more energy is lost in the transport. However, turbines close to land are considered an eyesore by some coastal communities, can produce a great deal of noise, and can be harmful to migrating birds. The turbines are also costly to build and install, and the lifecycle and end-of-life disposal must be considered. We need to ensure that we have a way to dispose of broken or old turbines at the end of their lifespans that is not detrimental to the environment. These and other factors must be taken into consideration when planning to utilize alternative energy sources.

**Students may think wind turbines on the ocean are not safe. They learn that electricity and water do not mix. You may need to provide additional explanation about how we can safely harness wind energy from the ocean.**

## Adaptation: Responding to a Changing Ocean

As we continue to use resources from the ocean, its future seems uncertain. Scientists have made predictions about what will happen if we continue to interact with the ocean as we do currently. Following is one common scenario that you may want to discuss with your students. Your students may have questions about whether this scenario could actually happen. After reading this scenario, look at the following section on actions and think about how you could discuss this scenario with your students.

### Can We Run Out of Seafood?

Imagine an ocean with no fish. Some predictions say we will deplete our fisheries of large fish within our lifetime—one report suggests that by 2048 we will have significantly depleted nearly all our fisheries to a point of collapse (Worm 2006). As discussed in Chapter 4, unsustainable fishing practices have greatly impacted the sea. By the early 21st century, we had overfished 90 percent of large fish species—the lions and tigers of the sea—leaving only 10 percent of top predators in the ocean (Myers and Worm 2003). We did not stop with the large fish, however. We have been overfishing small herbivorous fish such as mackerel and sardines as well (see Chapter 4). Over the course of this guide, we have discussed the many ways that different species are interconnected. When we overfish a species or population, the impacts are far reaching. No species disappears without impacting others. Without the small fish to keep them in check, populations of jellyfish could begin to swarm our shores and in fact are already blooming in numbers not seen in the past. While jellyfish are not the most nutritious source of food, without other seafood to eat, and with plentiful numbers, jellyfish could become a more common item on our plates. Anyone interested in a peanut butter and jellyfish sandwich?

Many cultures worldwide depend upon fish as a primary source of protein. Cultural traditions such as paella and lobster boils could be threatened as well. If we cannot get food from traditional sources—such as the ocean—reliably, we may move to other means, such as farming, which often includes clearing vast areas of forests and importing water to desert-like areas that cannot naturally support agriculture on a large scale.

In California, fishing plays an important role in the economy. Annually, commercial fisheries in the state bring in more than $100 million, providing jobs all along the coast (Port of San Diego 2010). If unsustainable practices cause the fisheries to collapse, that means a loss of more than $100 million to the state!

In short, decline of fish populations is not simply a sad tale for an individual fish species. The outcome could be detrimental to different ocean ecosystems—from the decline of species, to toxic blooms of plankton

**In northern Myanmar, this fisher propels his boat with his leg, freeing his hands for fishing. This fisher is practicing artisanal fishing.**

and jellies—as well as to terrestrial ecosystems as people try to compensate for changes in food sources. Humans have relied on ocean life from their earliest days, and we need to learn to protect and maintain this natural resource in sustainable ways.

## Actions: Protecting Our Ocean Every Day

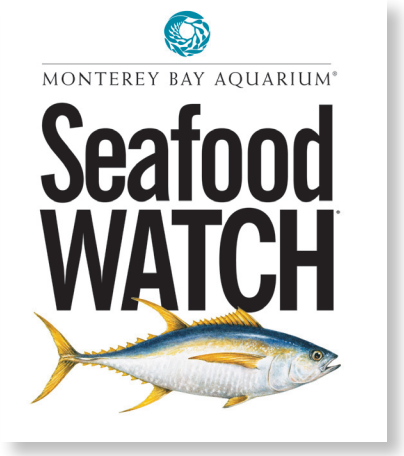
While the ocean has provided society with many great services, it is threatened by humans overutilizing those resources. While the previous section may seem grim, there are precautions we can take to ensure the ocean can provide for us and for generations to come in a healthy, sustainable manner.

**Sustainable Seafood.** While Marine Protected Areas, Individual Catch Quotas, and other fisheries management plans are helping to ensure the future of our fish stocks and the fishing industry, consumer choices can help as well. In Chapter 4, in the activity **Shop for Solutions!,** page 71, we looked at sustainable and non-sustainable fishing methods. When purchasing seafood, people can be sure to buy fish that is sustainably caught. This means that it is not fished in a style that damages the environment and does not take fish at a rate that depletes the population over time. People can choose aquaculture products that are farmed using techniques that do not degrade the surrounding environment and that are given feed that does not place pressure on other fish stocks. People can avoid products that are caught illegally or are on the protected list. Lastly, many people around the world can also simply reduce their consumption of seafood.

Organizations are working to help us make these choices more easily. Consumer guides are available from many reliable sources, such as the Monterey Bay Aquarium's Seafood Watch program (see http://www.montereybayaquarium.org/cr/cr_seafoodwatch/sfw_recommendations.aspx), and the Blue Ocean Institute's Seafood Guide (see http://www.blueocean.org/seafood/seafood-guide). In California, the Monterey Bay Aquarium Sustainable Seafood Initiative is working throughout the state to increase the number of restaurants that offer sustainable seafood. The Monterey Bay Aquarium has made it easy for seafood eaters to make sustainable choices. They publish a Seafood Watch Guide that they update constantly to tell consumers which fish products are the best choice, which are good alternatives, and which should be avoided. Items are classified by how they are caught or farmed and from what region they are caught or farmed. Shoppers can bring the printed card with them to restaurants and the seafood counter at the grocery store, or they can use the free iPhone application for those times that they forget the card at home. Blue Ocean Institute offers a text-messaging service, available from any cell phone. Simply text *fish* and the species name to 30644 and receive a text back with an assessment of the fish choice and alternatives for environmentally-unfriendly species. Individuals who want to make more of a difference in the seafood industry can become Seafood Watch Advocates and leave friendly, educational cards at restaurants or with fishmongers. With these cards, the advocates can either thank their supplier for providing "Best Choices," or they can inform the supplier of "Avoid" products offered, why the products are detrimental, and what alternative can be provided.

Consumers can also support restaurants and food stores that serve sustainable seafood. Monterey Bay Aquarium partners with many of these restaurants and, through science-based research, helps these restaurants change or plan menus that only offer products off the "Best Choices" and "Good Alternative" lists. Check their website for a restaurant near you that offers sustainable seafood or ask your local servers and restaurant owners where their fish comes from. Greenpeace, the environmental group, ranked common supermarkets with regarding the sustainability of their seafood products. Use guides such as these when going shopping.

**Reduce, Reuse, Recycle, Rot.** Our ocean is threatened by the amount of trash that ends up in the ocean and along our beaches—about 14 billion pounds per year (Green Guide 2008). As mentioned early in this guide, plastics are threatening entire food webs and ecosystems from purposeful and unintentional littering, and studies show that there is some level of plastic in any seafood that we consume. To help with this problem, we can remember the old adage "Reduce, Reuse, Recycle." The important part of this mantra is the




**To get the most up-to-date Seafood Watch pocket guide, log onto Monterey Bay Aquarium's website and print out or request a pocket guide, download the iPhone application, or join their Advocacy team (www.seafoodwatch.org). The Seafood Watch guide provides lists specialized to your region.**

order in which we practice our three *R*'s. The first part is to reduce the amount of trash that we create. Avoid buying things that will need to be replaced repeatedly. When you're at a grocery store, consider packaging when choosing a product; avoid using single-use plastic bags and bring reusable bags to the store; use goods and clothes until the end of their life rather than filling landfills with perfectly good, usable products. Donate unwanted items to a thrift store or local charity for household items and clothes that have life left in them. Someone else can reuse your unwanted items.

Many items in our lives have a usable life of minutes but last for years in the environment. It takes energy and raw materials to create things we throw away. This is where reusable items can come in handy. Bring reusable canvas bags or plastic and paper bags back to the store to help you carry purchases. A reusable shopping bag is a small investment that will last you years and keep thousands of single-use plastic and paper bags out of the environment. Reusable water bottles allow you to drink water wherever you go, without the cost of single-use plastic


**Support grocers that carry local and sustainable food options. (See http://go.greenpeaceusa.org/seafood/scorecards/scorecard_top20.pdf for more information.)**

water bottles. Reusable coffee mugs keep Styrofoam and paper cups out of the environment and can express your personality and be more unique than a coffee-shop cup. Many retailers give you money back for bringing in your own grocery bags or coffee mugs—adding a monetary incentive to the environmental action! Packing your lunch in reusable containers can add variety to your diet and help you to avoid unhealthy processed foods.

Recycle when you can. Paper grocery bags, and now, more frequently, plastic bags may be recycled. Even many electronics can be recycled at a local recycling facility or with the company that made the product. It is important to note that while recycling is less intensive on the environment than buying or using something new, it still requires energy, water and other materials. This is why it comes behind reducing our consumption, and reusing items.

As for the last *R, rot*, many paper and food scraps can be composted. This can occur in your backyard, in a community compost, or as is happening in many cities such as San Francisco and Los Angeles, through the local waste-collection company. The less waste we create, the less trash that will end up in the ocean.

If you can't follow the four *R*'s, then it is imperative that all your waste gets disposed of properly. Litter is a top cause of nonpoint-source pollution. Trash that blows on our streets and flows down our storm drains to the ocean has a huge negative impact on the environment. Plastic bags and balloons can look like sea jellies, candy wrappers like small fish, and small plastic pieces called nurdle (small pellets melted by manufacturers to make products) look like fish eggs—all may be ingested by animals in the ocean. Improperly disposing of chemicals, and even waste from our animals, can be detrimental. If you cannot find a way to reduce, reuse, recycle, or rot your trash, at least make sure it ends up in the trash can.

**Reduce Emissions.** We devoted an entire chapter to climate change, carbon emissions, and ocean acidification

## Teaching Tip

After lunch one day, have all students keep their trash. As a class, look at the waste. Have students brainstorm alternatives to a trashy lunch. Ask them to list actions that they would realistically do versus those that they would like to do but probably would not. This can be a great starting point for good discussions about why sometimes people decide to do things that aren't as sustainable as they could be.

because the issues are so important. Reducing our carbon-dioxide emissions can reduce our impact on the ocean from this perspective. Most people know that more-efficient vehicles, carpooling, taking public transportation, and walking or biking can help reduce our emissions and our **carbon footprint** (the amount of carbon dioxide we each produce through our daily action). But sometimes we feel we don't have any other option but to drive, and transportation choice is rarely up to students themselves. Some schools have begun walk-or-bike-to-school groups to help students get outside, get active, and reduce carbon footprints.

There are many other ways to reduce the energy we use. Unplugging electronics when they are not in use is an effective way to reduce energy usage as well as save money. Unplugging the television(s), computer, cellphone chargers, and other appliances when they are not in use greatly reduces the flow of energy that these products draw even when they are turned off. Appliances that still use energy when not in use while plugged in are known as energy vampires, sucking away at energy and money. Turning off the light when you leave a room is a simple activity than anyone can do! Replacing light bulbs with compact fluorescent bulbs (CFLs) also helps to reduce energy use and emissions. Using less water, in general, can also save energy. In California, nearly 20 percent of the state's energy use is spent just on moving water throughout the state (let alone treating it!), more than on any other action. Therefore, the less water we use, the less energy we use.

Another way to reduce emissions is to shop and eat locally. The less distance your food and other products travel to get to you, the less fuel they used to get there and the smaller an impact you are having. It may mean experimenting with new produce recipes or not purchasing the latest fashion, but local farmers and shop owners will appreciate your business. Studies are showing that local food grown in season tends to be more flavorful and vitamin rich too! And buying local means that your money stays in your local economy where it can directly impact your community.

You can also eat lower on the food web or at lower trophic levels. To produce a pound of beef, more than 1,500 gallons of water must be used! (NGM April 2010). This water must be pumped into the farms and processing plants, using fuel to transport it. More energy goes into harvesting grain for the cows, for processing the beef, and in transporting the cattle from the farm to the processing plant to the wholesaler and eventually to your table. If you reduce the amount of meat you eat, you reduce the energy needed to feed yourself and the amount of emissions released in that process. One source reports that, "if all U.S. residents reduced their consumption of animal products by half, we could save the equivalent of the annual flow of 14 Colorado Rivers" (Renault and Wallender 2008). Changing your lifestyle slightly can still have a big impact on our oceans!

## Teaching Tip

Students are often unaware of how many resources they use in their daily lives. Having them perform an energy or water audit can help them see how and where they use resources in their lives. One way to expand this lesson to include math skills is to have students each chart their energy use—they can use pie charts to divide how much energy they use in each activity or bar charts to see who in the class uses the most or the least. Additionally, you can challenge your students to reduce their resource use by 10 percent, 15 percent, and so on and have them calculate what the new amount would be. See who in class can reduce his or her impact the most by performing the audit before your lesson as a pre-test and again as a post-test.

In the Classroom

# Solutions From People

On June 6—8, 2010, the Aquarium of the Bay in San Francisco celebrated World Ocean Day. At the end of their tour through the Aquarium, visitors were invited to see animals that could be affected by climate change, listen to a sustainable-seafood talk, and touch some ocean-animal artifacts. They were also invited to color in a picture of Dr. Seuss's fish and write a message about how the visitors could protect the ocean. Following are some of the visitors' responses:

- Choose to eat sustainable seafood.
- Save energy.
- Save the fish.
- The first thing to do is to clean up the BP oil spill.
- Always use a Seafood Watch Card.
- Don't litter.
- Be eco-efficient.
- Don't drink bottled water.
- Recycle and compost.
- Watch for fish in danger.
- Don't put garbage in the ocean.
- Pick up litter—even if it's not yours.
- Don't support trawling.
- Keep trash out of the water.
- Obey fishing rules.
- Practice catch and release.
- Learn more about the ocean.
- Don't trash the ocean.
- Stop throwing trash and cans.
- Stop throw[ing] bubble gum [in the ocean/on the ground].
- Be aware of what you eat.
- Help clean the ocean.
- Do not pollute.
- Don't spill oil anymore.
- Have pick-up parties where people come and pick up [trash].
- No oil drill[ing] at the ocean.
- Be careful at the beach.

Show the responses to your students and have them group them into major categories. Ask students to explain how the different activities will positively influence and conserve the ocean. After students group and explain the different activities, have them discuss and decide which group of actions will have the most positive impact on the health of the ocean. Tell students that all the actions may have good consequences for the ocean, but students should think about the ones they believe will be most beneficial. Once they discuss their selection, have students share and explain why they believe their chosen action is of highest value for ocean health. As they explain the solutions and talk through their groups and their selections for highest impacts on ocean health, look at where students may have gaps in their knowledge and comprehension.

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Pictures of Practice

# Ocean Action

Given the many impacts humans have on our ocean and the extent of these impacts, it can be challenging and a bit overwhelming to make choices about how to reduce the harm done. One might ask, "Does it really matter that I purchase sustainable seafood when millions of people are not doing the same?" Taking action to protect our ocean is important at the individual level, even if it means picking up trash at the beach or choosing to eat at a restaurant that offers sustainable seafood. When these individual actions are aggregated across many people, real change can happen. Students seem to know that the ocean is in danger and that everyday actions impact the ocean, but they do not necessarily grasp the scope of the problem or the scale at which actions need to be taken. They also tend to characterize certain actions as "good" or "bad" without understanding why. Like many adults, children may view ocean-related issues as faraway problems or think that the ocean is so vast that it can handle the pressures put upon it. Other students may be interested in helping but may only focus on visible actions that individuals can take as opposed to collective actions by groups.

**Students: Grades 5 and 7**

**Location: California (coastal communities)**

**Goal of Video: The purpose of watching this video is to hear student ideas about actions for protecting the ocean and to think about how to use this information to plan instruction.**

## Classroom Context

Students in this video live near the California coast. The interview clips shown in this video were taken during the spring of the school year after both sets of students learned more about the ocean and ocean biodiversity. The first part of the video shows fifth-grade students describing actions to protect the ocean. The second half of the video shows seventh-grade students answering the same question. Think about the different types of responses you hear from students in the same grade as well as differences between grade levels.

## Video Analysis

In the video, students were asked what they can do to protect the ocean. A good answer to this question would not only include answers about reducing litter and pollution, but also would involve answers about choices as consumers. For example, protecting the ocean includes making choices about seafood and not buying too many disposable products such as plastics. However, as you listen to students' ideas, notice that students do not make the connection to consumer choices and actions.

## Reflect

### How would you help students learn about protecting the ocean?

Think about the obvious actions that students describe in their interviews. What patterns do you see in these responses across grades? How could you help students expand their understanding of ocean conservation and protection to include consumer choices? What concepts would you target?

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## Teaching Resources

California Coastal Commission's Waves, Wetlands, and Watersheds Curriculum. www.coastal.ca.gov/publiced/waves/waves_entire.pdf

California Education and Environmental Initiative resources: http://www.calepa.ca.gov/Education/EEI/default.htm

College of Exploration of Oceans. http://www.coexploration.org/ceo/

COSEE-California (Center for Ocean Science Education Excellence – California)http://www.coseeca.net/

MIT designed solar-powered portable desalination system http://web.mit.edu/newsoffice/2010/itw-portable-desalination-1015.html

Monterey Bay Aquarium Seafood Watch. www.montereybayaquarium.org.

National Geographic's Take Action http://www.sylviaearlealliance.org/