CHAPTER V

LIVING IN HARMONY WITH THE MARINE ENVIRONMENT

We have not inherited the Earth from our ancestors. We have borrowed it from our children.

Author Unknown

Past chapters have introduced you to many aspects of the marine environment—the ocean's vastness, the physical and chemical properties of the ocean and, the hydrologic cycle. We have also looked at the plants and animals that live in a wide variety of coastal and oceanic habitats, and the adaptations that have enabled them to survive in these areas. The importance of coastal wetlands and the dynamic environment of barrier islands have also been addressed.

These chapters however, for the most part, have not addressed human impact on the ocean environment. We know, from previous chapters, that physical and chemical properties of the ocean are delicately intermingled to produce one of the most self-sustaining life support systems on earth. In this chapter, we discuss how human activity can very easily–and oftentimes, undetectably–offset this self-sustaining ocean system. The ocean has its own way of telling us that the system is becoming unbalanced. In many cases, however, the ocean shows signs of human-induced imbalance far too late for us to change our actions–actions that have permanently affected a once self-sustaining, natural system.

Photo by CHERIE PITTILLO

Figure 5-1. *Recreational fishing using a cast net.*

A. Resource Utilization

Ocean resources have supported the activities of humans for thousands of years, whether these activities were a means of basic survival or enjoyment and recreation. Historically, the ocean has been used for fishing, transportation, and recreation (Fig. 5-1). The development of new technologies has opened the door for other uses of the ocean as a resource. Advancements in technologies have enabled us to mine the ocean for fuels, such as petroleum and natural gas. In fact, over $1 million a day is spent in search of oil within the ocean floor in the Gulf of Mexico.

Metals, such as gold, silver, tin, and iron are mined from the ocean floor. Manganese (Mn^{2+}) nodules are extremely abundant in certain areas on the ocean floor. Calcareous shells taken from the ocean serve as a source

of calcium carbonate ($CaCO_3$) which is used in the production of cement and fertilizer. Minerals taken from the ocean include salt, magnesium, and bromine. Even fresh water is extracted from sea water for human use. The ocean can also be used as a source of energy through tidal power and serves as a large open area from which to collect the wind's energy.

More recently, aquaculture, or the intensive culture of marine (and freshwater) organisms, has become an increasingly popular use of ocean resources (Fig. 5-2). In fact, explosions in population growth on a global level will most certainly necessitate increased utilization of the ocean as a source of food. Additionally, scientists are just beginning to unlock the medicinal possibilities of the ocean through the discovery of antibiotics and other drugs that can be produced by marine organisms.

Many of us tend to think of a resource as something that is available to us–a supply, a stock, or a means of support. More often than not, we have viewed the ocean as a renewable resource, or one that is unlimited in its bounty and ability to renew itself. But recently, we have learned quite the opposite–that the ocean is limited in what it can provide. We have seen declining fish populations off our own coast, we have removed dead animals that have become entangled in fishing line and nets from our beaches. Additionally, we remove tons of marine debris, including medical wastes, from the beach every year. In fact, in recent years, there have been more closures of public beaches throughout the country than has ever occurred before.

Human activities such as mass taking of marine organisms for food have certainly expressed their effects on the populations of marine organisms, particularly in light of poor management strategies and more effective technologies used to locate and catch marine organisms. Total fish production, including aquaculture, had increased from approximately 18 million tons in the mid-1940s to

Photo by CHERIE PITTILLO

Figure 5-2. *Aquaculture farm.*

101.3 million tons in the early 1990s. Estimates of fish stocks overfished around the world range from 36% in the East Central Pacific to 90% in the Pacific and the West Central Pacific. An estimated 53% are overfished in the South Atlantic, with sharks, tuna, swordfish, marlin, sailfish, drum, croaker, and weakfish reported as species in trouble and the shortnose sturgeon being reported as in danger of extinction (Bureau of the Census, US Department of Commerce, FAO).

Additionally, we have seen that fishing for target species can, in certain cases, affect other animals, such as porpoises and dolphins, that live in close association with the sought-after organisms. We now understand that the ocean is not a limitless bounty–it is very easily altered by human activity. We have yet to learn the consequences of many of our actions, both past and present.

B. Coastal Development and Erosion

Over one-half the population of the United States lives within 160 kilometers (100 miles) of the coast, with coastal populations reaching five times the national average. Consequently, wetlands are impacted by human development, as they receive pollutants from a variety of sources, including runoff from inland areas. Local stormwater runoff, wastewater discharges, and other residential and industrial activities also affect wetland habitats. Atmospheric deposition and oil seeps are naturally-occurring sources of wetland pollution. One of the most important functions of wetlands is that they serve as filters for pollutants since they trap contaminants from both natural and human-induced activities in their sediments and purify some of the waters passing through them. Wetlands can, however, become overloaded with pollutants from a variety of sources if the input of the pollutants occurs at a rate which is faster than the purifying capacity of the wetland.

It has been estimated that both naturally-occurring and human-induced activities have resulted in an estimated loss of over half of the Earth's existing wetlands. Despite present day knowledge of the function and value of wetland resources and international efforts to halt their loss, these fragile habitats are disappearing at a rate of 1,214 square meters (300,000 acres) each year. Additionally, with estimates that 75% of our nation's population will live within 80 kilometers (50 miles) of the coast by the year 2000, human-induced activities near coastal wetlands are certain to result in increased stress on these fragile areas.

Because barrier islands are in a constant state of flux, they are not suitable areas for dense human populations to reside. The continual change makes it nearly impossible for permanent dwellings to exist on the shoreline. Erosion, or the loss of shoreline, is frequently caused by storms, winds, high tidal surges, and/or man-made structures. Coastal areas nationwide have subsided a total of 20 centimeters (8 inches) during the past 100 years due to sea level rise and natural subsidence, or settling, of these coastal areas. According to the United States Environmental Protection Agency, scientists estimate that we can expect a subsidence of 0.7 to 1.4 meters (2.3 to 4.5 feet) over the next 100 years. The Agency also estimates that the Charleston, South Carolina area alone could see a loss of 50% of its coastal marshes if it experiences just a 1 meter (3-foot) rise in sea level.

Erosion rates vary along the Southeastern U.S. coast. Estimates for South Carolina's coast, for example, indicate that one-fourth to one-third of the coastline is eroding and 97 kilometers (60 miles) of the coast are critically eroding at a rate of over 0.3 meters (1 foot) per year. Erosion of North Carolina and northern South Carolina beaches is primarily the result of wave action, as tidal ranges are relatively small (microtidal). Farther south, along South Carolina's mesotidal beaches, erosion is due to

the combination of wave and tidal action, and Georgia's beaches are being eroded primarily by tidal action.

Humans interfere with the ocean's force and the natural migration of these barrier islands by placing seawalls, bulkheads, groins, and jetties on beaches in an effort to protect the existing beach, which consists of both public and private property, against these natural forces. Each of these man-made structures is defined below:

- seawall—a solid, vertical structure constructed parallel to the beach
- bulkhead—a sloping barrier often composed of large rocks placed parallel to the beach
- groin—a vertical structure placed perpendicular to the shoreline that extends from the upper edges of the beach to beyond the low tide mark (Fig. 5-3)
- jetty—rocks or other structures, placed perpendicular to the shoreline, that extend seaward from the upper edges of the beach; typically used to stabilize migration of inlets; often placed in harbors to slow natural longshore drift of sand and subsequent sand build-up in the harbor. Examples are the Charleston Harbor Jetties and the Georgetown Jetties off South Carolina.

These man-made defenses against natural barrier island migration only exacerbate erosion, particularly in areas immediately adjacent to these "ocean barrier" structures.

Additionally, the loggerhead turtle, a threatened species on the state and Federal Threatened and Endangered Species List, crawls

Figure 5-3. *Groin made from concrete, steel and rock.*

Photo by CHERIE PITTILLO

onto to barrier island beaches at night from May through October to lay eggs in the dunes. Alteration of nesting habitat and blocking access to dune nesting areas by man-made structures clearly has had significant impact on this species.

In 1988, the South Carolina General Assembly passed the Comprehensive Beachfront Management Act to protect coastal areas from conflicts with development by setting policies that addressed altering sand in dune systems and erosion control. It also called for the establishment of a setback line for placement of erosion control devices and coastal development.

C. Pollution

'If seven maids with seven mops
Sweep it for half a year,
Do you suppose,' the Walrus said,
'that they could get it clear?'
'I doubt it, said the Carpenter,
'and shed a bitter tear.'

from: *"The Walrus and the Carpenter"*
Through the Looking Glass
by Lewis Carroll (1871)

The 20th anniversary of the national legislation protecting public bodies of water and aquatic resources, known as the Clean Water Act, was celebrated in 1992. Over 40 governors and the past President of the United States proclaimed 1992 as the Year of Clean Water. Nevertheless, there has been a steady decline in public understanding of water as a limited, natural resource as well as a lack of pollution prevention technology to assist people with protecting water resources. In fact, over one-third of the nation's shellfish beds are closed due to pollution. As the number of people living in coastal areas around the country continues to increase, an increase in ocean pollution is certain to occur.

We frequently hear the terms "point source" and "nonpoint source" pollution. Point sources of pollution are simply sources of pollution that can be tied to a single source, such as discharge into a river from a pipe (Fig. 5-4). Nonpoint sources of pollution cannot be tied to a single source. An example of nonpoint source pollution is stormwater runoff from an entire watershed into a coastal body of water.

Photo by CHERIE PITTILLO

Figure 5-4. *Point-source pollution.*

Point and nonpoint sources of pollution affecting coastal waters along the Southeastern U.S. coast include stormwater runoff from land areas after heavy rains, runoff from agricultural areas, discharges of industrial wastes, and releases from sewage treatment plants. Dredging, construction operations, offshore drilling for oil, shipping, and recreational activities also constitute ways in which the coastal and oceanic environments can be altered by human-induced activity.

In the past several years, problems with marine debris, or garbage disposed in the ocean, has been foremost on the minds of many environmentalists, particularly those concerned about ocean resources. Disposal of plastics in the ocean is of particular concern, since plastics are durable and do not readily break down. A plastic six-pack ring can take up to 350 years to degrade and poses a potential threat to small animals that may become entangled within the rings.

Plastic in the ocean causes problems for two reasons: 1) entanglement and 2) ingestion. Many marine organisms become entangled in plastic netting and line used in fishing activities. Additionally, many marine organisms; including porpoises, dolphins, and turtles; ingest small plastic pieces, Styrofoam, or plastic bags since these items resemble the food upon which these organisms frequently feed. In fact, plastic has been found in the stomachs of over 50 species of the world's 250 species of seabirds. Additionally, these seabirds take plastic pieces back to their nests as food for young chicks.

Another form of pollution that we hear or read about, but often do not correlate with alteration of the ocean environment, is the release of compounds that deplete the ozone layer and increase levels of carbon dioxide (CO_2) in the atmosphere. Levels of CO_2 have increased by 25% during the past 200 years. These increased levels of CO_2, coupled with the depletion of the ozone layer, result in warmer temperatures on Earth, often referred to as global warming. Warmer temperatures, in turn, cause melting of the polar ice caps and a resulting rise in sea level. Changes in the global ocean's salinity and temperature will surely take place as a result of this gradual melting of the polar ice caps due to global warming. A rise in sea level will submerge many productive coastal marsh areas. Weather patterns will also change and, in turn, will affect ocean circulation.

It is unfortunate that it takes disasters like the Alaskan oil spill in Prince William Sound from the Exxon *Valdez* tanker, medical wastes washing up on beaches, and closure of public waterways to fishing and swimming to capture the attention of many people and educate them about ocean pollution. Progress is being made, however, in making people more aware of the problems caused by ocean pollution. The International Coastal Cleanup, one of the planet's largest volunteer cleanups, is an annual event in which more than 50 U.S. states and territories and more than 75 countries participate. For over ten years, South Carolina has held its cleanup–Beach Sweep/River Sweep (Fig. 5-5). On that day, thousands of volunteers flock to the state's beaches and waterways and clear away anywhere from 50 to 70 tons of aquatic debris. The Sweep has resulted in a tremendous increase in the awareness of the problems with disposal of trash in oceans and in waterways. Pollution prevention efforts, such as recycling and use of environmentally friendly products, coupled with education about the marine environment and the formation of regulations by an aware and educated public, are clearly steps in the right direction.

Figure 5-5. *South Carolina's Beach Sweep/River Sweep program.*

D. Endangered and Threatened Species

As we discussed in Chapter 3, organisms develop very unique adaptations that allow them to survive in certain habitats. Adaptations enable organisms to fill very specialized niches within these habitats. An organism's niche affords an abundance of food, shelter, and protection from potential predators so that the organism survives and successfully reproduces, thereby ensuring continuation of its species.

Human activities, as we have seen, can alter the delicate balance of the environment. This "tilting of the balance" also expresses itself in the niches of many organisms. Slight alterations in habitat can cause organisms to compete with one another for a place within a niche. When this competition fails, the "losing" species can become extinct if it is unable to readily adapt to a new habitat and become successful in its new niche.

When a species becomes extinct, it is no longer in existence–it is lost to the world forever. Species that are termed "endangered" are in danger of becoming extinct because their populations have been reduced to very small numbers, usually as a result of negative human-induced impact upon the species itself or its habitat. Examples of extinct marine organisms include many species of invertebrates, such as the trilobites, which are "cousins" to shrimp and crabs. Trilobites were very similar to the modern horseshoe crab, which are, in fact, their only "living relative!" Many species of vertebrates, including fishes, have become extinct. Marine organisms currently in danger of becoming extinct include certain species of whales, seals, and sea turtles. Species that are "threatened" have decreasing population levels or could experience population decreases because their numbers or available habitat is decreasing. If population levels of these organisms continue to decline or available habitat continues to be lost, these threatened organisms could be listed as endangered, and ultimately, become extinct.

The passenger pigeon and the Carolina Parakeet once occurred in the Southeastern United States. They are now both extinct. Examples of endangered or threatened species in the region include the morning glory, the Venus' flytrap, the yellow honeysuckle, the ivory-billed woodpecker, the loggerhead turtle, the Eastern brown pelican, the Southern bald eagle, the wood stork, and the swallow-tailed kite.

E. Our Coastal Heritage

Webster's dictionary defines heritage as "property that is or can be inherited," "something handed down from one's ancestors or the past," "ancestry," "gift," and "birthright." Coastal areas have been used by humans for thousands of years, as these areas were once inhabited by the Native American Indians. Humans have used these areas for cultivation and harvesting of food, commerce and trade, and defense of a young nation. Today, we use these areas for some of these same types of activities, but to a much larger degree. The coast is under more stress from human-induced activity than it has ever been before. With the startling projections of population increases in coastal areas around the country, this stress will only continue to increase.

It is our coastal heritage, or birthright, to protect our nation's waterways and coastline. Throughout each of these chapters, we have seen how valuable these areas are. They are home to the smallest of bacteria living in the sediment on the mud flat. They are temporary homes to a myriad of other organisms, including shrimp, crabs, and fishes, and other organisms that use these areas as nursery grounds. These coastal areas also supply an abundance of nutrients to near coastal waters. Organisms using coastal areas as nursery grounds eventually move offshore to their adult habitats, providing another link in the

food web leading to higher level predators inhabiting offshore waters.

Crabbing, fishing, boating, walks on the beach at sunset, and adventures in "marsh classrooms" are just a few of the opportunities that we have been given as part of our coastal heritage. We have also received the contamination that has been handed down from past generations–generations that did not recognize the consequences of their actions. We now know what some of these consequences are, and it is our responsibility to pass this information on to others who have yet to learn. Finally, ensuring that these fragile coastal areas continue to exist for the responsible enjoyment of future generations is our obligation.

F. Young Children and Environmental Stewardship: It's Our Responsibility

A steward is defined as "a person entrusted with the management of estates or affairs not their own." Environmental stewardship is, therefore, entrusting people to reasonably manage their activities so that they have minimal effects on our environment. Young students are, by far, the most receptive to becoming environmental stewards, or leaders. There are many ways to introduce children to environmental stewardship and teach them the proper behavior and actions that are so very critical to survival of all species on the Ocean Planet. Participation in the following activities are certain to instill some degree of environmental stewardship in your children:

- Use of hands-on activities in the classroom and understanding the connection and application of those activities to the environment
- Adopt-A-Beach/Adopt-A-Highway programs
- Beach Sweep/River Sweep, an annual cleanup
- Recycling programs at home or at school
- Membership in science clubs
- Family science enrichment programs
- Field trips to nature centers and other programs offering outdoor environmental education activities
- School gardens
- School nature trails and nature walks
- Classroom aquaria and other live educational exhibits
- Last, and most importantly, a teacher who is not afraid to say "I do not know" and who is willing to explore all possible answers with his or her students.

It is our hope that you have learned something about the marine environment from this text. We started this text with a chapter that described the Ocean Planet as a small, beautiful electric-blue sphere suspended by nothing in the black void of space. We have ended with a chapter focusing on how we, existing simply as another species on the Ocean Planet, have developed behaviors and technologies that alter this fragile ecosystem on a daily basis.

It has not been too many years ago that we were hearing discussions about how water supplies would one day not be fit for drinking. Many of us probably thought this "one day" would occur during some future generation–long after we ourselves or our families continued to exist on the Ocean Planet. Today, many of us purchase bottled water for our own homes. But we have a great advantage over all the other species on earth–we have the ability to reason and make intelligent decisions. This reasoning and ability to make intelligent decisions must guide our actions and change the affect that our actions have on the Ocean Planet.

So the next time you are out calmly cruising the creeks or walking along the edge of a salt marsh, consider the complexity and value of this environment. At the same time, consider

point and nonpoint source pollution, marine debris, overharvesting of marine species, marinas, boat ramps, condominiums along the water's edge and the massive influx of people occurring at an alarming rate in coastal areas throughout the country. As educators, you should take the responsibility to impart some of this information to your young students to increase their awareness of this fragile marine environment. Maybe then, some of these future leaders will understand that fish, crabs, shrimp, and oysters do not always come surrounded with French fries and cocktail sauce. Perhaps, too, this next generation of leaders, residents, and visitors to these wonderful coastal environments will truly be environmental stewards–people we can trust "with the management of estates or affairs not their own."

"Together we have an opportunity to enlighten the naive, encourage the complacent and empower a generation to protect our precious world."

Ann-Margret

Photo by CHERIE PITTILLO