CHAPTER 13

SUSTAINING AQUATIC BIODIVERSITY

Summary

1. Aquatic biodiversity refers to the composition of plants and animals in the fresh and salt waters of the planet. Its economic importance lies in the 6% of protein and 20% of animal protein taken from the water. Chemicals from aquatic plants and animals are valued at $400 million per year. Medicines have been developed from sea organisms: sponges, anemones, puffer fish, porcupine fish, seaweeds, etc. The waters are used for extensive recreational activities and commercial transportation.

2. Human activities are undermining aquatic biodiversity by introducing non-native species, and by destroying and degrading coastal wetlands, coral reefs, mangroves, and the ocean bottom. About three-quarters of the world's commercially available fish stocks have suffered serious declines. Efficient fishing techniques and the size of bycatch have greatly contributed to the decline of the global fishery.

3. To protect, sustain, and restore marine biodiversity we need comprehensive legislation, more funding for research, ecosystem-based fisheries management, and a network of marine reserves. We must identify and protect species that are endangered and/or threatened. This entails cleaning up aquatic environments, and inventing fishing methods that do not destroy animals and birds inadvertently by being caught in fishing nets. Poaching and illegal harvesting of marine creatures must also be eliminated. Public aquariums can also educate the public about protecting marine animals and birds.

4. The world's marine fisheries can be managed by setting catch limits below the maximum sustained yield limits, reducing or eliminating fishing subsidies, and charging fees for fishing in publicly owned offshore waters. Some areas can be protected from any kind of fishing; there should be more marine protected areas and more integration of coastal management practices. Net-escape devices should be developed for fishing boats. Marine fisheries can be protected by restricting locations of coastal fish farms, controlling pollution, and decreasing the release of polluting ship ballast water into the sea. Multispecies management of large marine systems offers hope for conserving marine resources and for renewing those resources.

5. Freshwater fisheries, lakes, and rivers can be protected, sustained, and even restored by building and protecting populations of desirable species, preventing overfishing, and maintaining and defending habitat quality. Public education will help garner support for necessary management actions.

6. Wetlands provide us with many ecological services, as well as recreational, educational, and economic opportunities. Many wetlands have disappeared due to agriculture or development. The Ramsar Convention helps protect wetlands of international importance and many local communities are carrying out wetland restoration.

Key Concepts and Learning Outcomes

After completing this chapter, students should be able to answer the following key questions.

13-1 What Do We Know about the Earth's Aquatic Biodiversity? Some, but Not Nearly Enough

A. We know very little about the Earth's aquatic biodiversity because there has been so little exploration of the water on this "water planet."
   1. Four actions have been identified that will help coastal water conditions.
      a. Comprehensive legislation is needed to protect, sustain, and restore oceans.
      b. More funding is needed for research.
      c. Management should focus on preserving aquatic ecosystems and habitats, rather than focusing on catch limits for individual species.
      d. A network of marine reserves, linked by corridors, is needed to protect fish breeding and nursery grounds.

13-2 What Are Some General Patterns of Marine Biodiversity? Abundant Life Near the Water's Edge and in the Deep

A. Coral reefs, coastal areas, and the ocean bottom are centres of marine biodiversity.
   1. The greatest marine biodiversity occurs in coral reef, estuaries, and on the deep-sea ocean floor.
   2. Biodiversity is higher near the coasts because of the great variety of producers, habitats, and nursery areas.
   3. Biodiversity is higher in the bottom region than in the surface region of the ocean because of the greater variety of habitats and food sources.
   4. The lowest marine biodiversity probably is found in the middle depths of the open ocean.

13-3 Why Should We Care about Aquatic Biodiversity? Keeping Us Alive and Supporting Our Economies

A. Marine systems provide a variety of ecological and economic services. Globally, about 6% of the total protein and about 20% of the animal protein is derived from marine fish and shellfish.
   1. Seaweeds provide chemicals used in cosmetics and pharmaceuticals, a $400 million per industry.
   2. Antibiotic and anticancer chemicals have also been extracted from a variety of algae, sea anemones, sponges, molluscs, and several species of fish.
   3. Freshwater systems offer important ecological and economic services as well.

13-4 How Has Habitat Loss and Degradation Affected Marine Biodiversity? Our Large Aquatic Footprints

A. The greatest threat to the biodiversity of oceans is loss and degradation of habitats.
   1. About half the world's coastal wetlands were lost in the last century.
   2. Coral reefs are severely damaged, mostly by human activities, and by 2050, 70% or more of the world's coral reefs may be severely damaged or eliminated.
   3. More than 50% of mangrove swamps have disappeared because of clearing for development, crops, and aquaculture.

4. Dredging and trawling are destroying many bottom habitats. Scientists signed a statement to urge the United Nations to ban bottom trawling on the high seas.

13-5 How Have Human Activities Affected Marine Fish Populations and Species? Gone Fishing, Fish Gone

A. About 90% of the commercially valuable marine fish species are either overfished or fished to their sustainable limits.
   1. Overfishing leads to commercial extinction, which is usually a temporary depletion if areas are allowed to recover.
   2. Big fish of commercially valuable species are becoming scarce.
   3. During the last 45 years, the abundance of large, open-ocean fish has plummeted by 90%.
   4. Two hundred and thirty populations of marine fish suffered an 83% drop in breeding population size from known historic levels. Destruction of habitat may mean that some of these species may never recover.
   5. The fishing industry has begun to harvest faster-growing varieties at lower trophic levels. Food webs will be disrupted if this continues, hindering the recovery of larger fish species due to loss of their food sources.
   6. Because of fishing methods, almost one-third of the fish caught are bycatch: fish that are thrown overboard either dead or dying.

13-6 How Have Human Activities Affected the Survival of Aquatic Species? Many Extinctions on the Horizon

A. Fish are threatened with extinction by human activities more than any other group of species.
   1. Freshwater species are disappearing five times faster than land animals.
   2. The seahorse is vulnerable to extinction because it is used (in dry form) in Chinese medicine.

13-7 How Have Non-native Species Affected Fish Populations and Species? Invasive Species Are Changing Aquatic Ecosystems

A. Non-native species are an increasing threat to marine and freshwater biodiversity.
   1. They disrupt ecosystems, displace native species, and cause extinction of native species.
   2. Non-native aquatic species arrive in ship ballast water. This can be lessened by requiring ships to discharge ballast water and replace it with saltwater at sea before entering ports, to sterilize ballast water or to pump nitrogen into it.
   3. The Eurasian ruffe, spreading rapidly in Lake Superior and Lake Huron, and the round goby, an aggressive bottom-feeder, were both introduced into North America in ballast water of foreign ships.
   4. Rusty crayfish, native to the Ohio River, were introduced by fishermen using them for bait and by aquarium hobbyists. They out-compete local species.
   5. Other non-native species include spiny water fleas, fishhook fleas, and aquatic plants (e.g., the Eurasian watermilfoil and fanwort).

13-8 Why Is It Difficult to Protect Marine Biodiversity? Out of Sight, Out of Mind

A. Protecting marine diversity is difficult because of the following factors:

1. the pressure of coastal development, sediment, and waste that threaten shore-hugging species and highly productive coastal ecosystems
2. the inability to see damage to oceans
3. the belief that the size of the ocean keeps it from being damaged
4. the lack of international agreements to protect the ocean, leading to a "tragedy of the commons"

13-9 How Can We Protect Endangered and Threatened Marine Species? Legal Agreements and Awareness

A. Laws, international treaties, and education can be used to help reduce the premature extinction of marine species.
   1. To protect marine biodiversity, we must
      a. identify and protect endangered, threatened, and rare species, and
      b. regulate and prevent aquatic pollution.
   2. Three of eight major sea turtle species are endangered due to
      a. degradation or loss of beach habitat;
      b. legal and illegal gathering of eggs;
      c. the use of turtles as food, jewellery, leather, and medicinal ingredients; and
      d. commercial fishing boats.
   3. Legislation aimed at protecting marine species includes the following:
      a. the 1975 Convention on International Trade in Endangered Species (CITES)
      b. the 1979 Global Treaty on Migratory Species
      c. the 1995 International Convention on Biological Diversity

13-10 What Is the Role of International Agreements and Protected Marine Sanctuaries? Hopeful but Limited Progress

A. Nations have established marine sanctuaries, but many are only partially protected.
   1. Nations have sovereignty over waters and the seabed up to 19 kilometres offshore.
   2. The Exclusive Economic Zone (EEZ) extends 320 kilometres out from shore, but too often these areas have not been regulated to sustain fish harvest; rather, they have been overfished.
   3. The World Conservation Union helped establish a global system of marine protected areas (MPAs).
      a. There are about 100 marine reserves in the world; Australia has established the largest one.
      b. Studies show that within as little as two years after establishing a reserve, the fish are larger, reproduce more often, and are in greater variety than previously.
   4. A group of marine biologists have called for the protection of 20% of the ocean's surface by 2020.
   5. Marine biologist, Elliott Norse, proposed the establishment of movable marine reserves (i.e., ones that move with the animals as they migrate in the ocean).

13-11 What Is the Role of Integrated Coastal Management? Cooperation Can Work

A. Integrated coastal management is a community-based effort to develop and use coastal resources more sustainably.

1. The idea is to find cost-effective, adaptable solutions to preserve biodiversity while meeting economic and social needs.
2. This effort uses the principles of adaptive ecosystem management.

13-12 How Can We Manage Fisheries to Sustain Stocks and Protect Biodiversity? Many Ideas

A. There are ways to manage marine fisheries more sustainably so that marine biodiversity is protected.
   1. Overfishing is a serious threat to biodiversity in coastal waters and to some marine species of open-ocean waters.
   2. One way to prevent overfishing is to develop better ways to project fish populations.
   3. The maximum sustainable yield mathematical model is used, but indications are that it has hastened the collapse of most commercially valuable stocks for several reasons.
      a. Populations and growth rates are difficult to measure.
      b. Sizes of fish stocks are often based on unreliable or underreported catch figures.
      c. Harvesting a species at maximum sustainable yield can affect other target and nontarget fish species.
      d. Fishing quotas are difficult to enforce.
   4. Optimum sustainable yield is a concept that takes into account interactions with other species and allows more room for error.
   5. Another approach is multispecies management of a number of interaction species, which accounts for competition and predator–prey interactions.
   6. There has been limited management of several large marine systems, such as the Mediterranean Sea.
   7. Many fisheries scientists and environmentalists are interested in using the precautionary principle for management of fisheries and marine systems.

13-13 Should We Use the Marketplace to Control Access to Fisheries? Good and Bad News about an Interesting Idea

A. Some countries use individual transfer quotas (ITQs) that are assigned to each fisherman. These ITQs can then be bought, sold, or leased, like private property. This has resulted in some reduction of overfishing, but it is hard to enforce. Wasteful bycatch has not been reduced.
   1. Four problems occur with the ITQ system:
      a. It transfers public ownership to private fishers, but still makes the public responsible for the cost of management and enforcement. Remedy this by collecting fees from quota holders to pay for the costs of enforcement.
      b. Small fishing vessels and companies may be squeezed out if they cannot afford to buy ITQs from others.
      c. Poaching may increase. Remedy this by strict record keeping and observers on all vessels with quotas.
      d. Fishing quotas are often set too high, so leave 10 to 50% of the estimated MSY (maximum sustained yield) as a buffer to protect the fishery from decline.

13-14 How Can Freshwater Fisheries Be Managed and Sustained?

A. Sustainable management of freshwater fish involves encouraging populations of commercial and sport fish species, preventing overfishing, and maintaining habitat quality.
   1. Regulate fishing seasons and the number and size of fish taken.
   2. Protect spawning beds with vegetation buffer zones.
   3. Remove barriers to fish migration and ensure a sufficient water supply.
   4. Ensure that boulders and coarse woody debris are available.
   5. Increase public education to gain support for management actions.
   6. Enforcement is necessary.

13-15 How Are Wetlands Regarded in Canada? Some Progress

1. Wetlands are worthy of protection as they are centres of biodiversity.
2. They have many roles.
   a. They provide habitat.
   b. They filter pollutants from water and prevent floods.
   c. They slow erosion and store greenhouse gasses.
   d. The present recreational, educational, and economic activities.
3. About 75% of wetlands in the Prairie pothole region are gone. In southern Ontario, about 70% of wetlands have been drained for farms and subdivisions.
4. Wetlands are protected by the following:
   a. the North American Waterfowl Management Plan, and
   b. the 1981 Convention on Wetlands of International Importance (the Ramsar Convention). Canada has 37 Ramsar sites.
5. Provincially significant wetlands are protected from development and may give tax advantages to private owners of these areas.