# Chapter 8

# Aquatic Biodiversity

### Chapter Outline

*CORE CASE STUDY Why Should We Care about Coral Reefs?*

**8-1 What Is the General Nature of Aquatic Systems?**

**8-2 Why Are Marine Aquatic Systems Important?**

*SCIENCE FOCUS We Are Still Learning about the Ocean’s Biodiversity*

**8-3 How Have Human Activities Affected Marine Ecosystems?**

*CASE STUDY The Chesapeake Bay—An Estuary in Trouble*

**8-4 Why Are Freshwater Ecosystems Important?**

*CASE STUDY River Deltas and Coastal Wetlands—Vital Components of Natural Capital Now in Jeopardy*

*Individuals matter Alexandra Cousteau: Environmental Advocate, Filmmaker, and National Geographic Emerging Explorer*

**8-5 How Have Human Activities Affected Freshwater Ecosystems?**

*TYING IT ALL TOGETHER Coral Reefs and Sustainability*

### Key Concepts

8-1A Saltwater and freshwater aquatic life zones cover almost three-fourths of the earth’s surface, with oceans dominating the planet.

8-1B The key factors determining biodiversity in aquatic systems are temperature, dissolved oxygen content, availability of food, and access to light and nutrients necessary for photosynthesis.

8-2 Saltwater ecosystems provide major ecosystem and economic services and are irreplaceable reservoirs of biodiversity.

8-3 Human activities threaten aquatic biodiversity and disrupt ecosystem and economic services provided by saltwater systems.

8-4 Freshwater ecosystems provide major ecosystem and economic services, and they are irreplaceable reservoirs of biodiversity.

8-5 Human activities threaten biodiversity and disrupt ecosystem and economic services provided by freshwater lakes, rivers, and wetlands.

### Key Questions and Case Studies

**CORE CASE STUDY**: **Why should we care about coral reefs?** Coral reefs are highly biodiversity, and they provide us with many ecological and economic services. They serve to sequester carbon, buffer coastlines, and provide valuable habitat. Globally, 19% of reefs have been destroyed and another 20% have been degraded. An additional 25–33% could be lost in the coming decades. Degradation and loss of reefs is an indicator that should serve as a warning about threats to the health of oceans.

**8-1 What is the general nature of aquatic systems?**

A. Saltwater and freshwater aquatic zones cover about 71% of the earth’s surface.

B. Salinity of the water determines the major types of organisms found in an aquatic environment.

C. There are four major types of organisms in aquatic systems:

1. Plankton are free-floating, weakly swimming, generally one-celled organisms. There are three major types of plankton: phytoplankton (plant plankton), zooplankton (animal plankton), and ultraplankton, which are no more than two micrometers wide and are photosynthetic bacteria.

2. Nekton is a second group of organisms. These are fish, turtles, and whales.

3. Benthos are bottom dwellers.

4. Decomposers are a fourth group. These organisms break down organic matter.

D. In aquatic systems, the key factors determining the types and numbers of organisms are temperature, dissolved oxygen, sunlight availability, and nutrient availability.

1. Photosynthesis is largely limited to the upper layers, or photic zone, which can be diminished by turbidity.

**8-2 Why are marine aquatic systems important?**

A. Oceans have two major life zones: the coastal zone and the open sea.

B. The coastal zone interacts with the land, and so much is affected by human activities.

1. Ecosystems in coastal zones have a high net primary productivity per unit area. They constitute 10% of the oceans and contain 90% of all marine species.

2. The coastal zone extends from the high-tide mark on land to the edge of the continental shelf.

3. Estuaries and coastal wetlands are subject to tidal rhythms, runoff from land, and seawater that mixes with freshwater and nutrients from rivers and streams.

4. Mangrove forest swamps grow in sheltered regions of tropical coasts.

5. Coastal wetlands/estuaries make nutrients available due to constant stirring of bottom sediment.

6. These areas filter toxic pollutants and excess plant nutrients, reduce storm damage, and provide nursery sites for aquatic species.

C. Organisms living in the intertidal zone have adapted to survive the daily changes in wet/dry conditions and changes in salinity.

D. Barrier beaches/sandy shores are gently sloping; organisms tunnel or burrow in the sand to survive daily changes in conditions.

E. Low, sandy, narrow islands that form offshore from a coastline are barrier islands. They generally run parallel to the shore.

F. Coral reefs are home to ¼ of all marine species.

**SCIENCE FOCUS: We are still learning about the ocean’s biodiversity**.

The ocean contains a much higher biodiversity of microbial life than has previously been thought.

G. The open sea is divided into three vertical zones based primarily on penetration of light.

1. The euphotic zone

2. The bathyal zone

3. The abyssal zone

**8-3 How have human activities affected marine ecosystems?**

1. Human activities are greatly affecting the ecological and economic services provided by marine ecosystems.

 1. Studies suggest 41% of the world’s ocean area has been heavily affected by human activities.

 2. About 45% of the global population lives along coasts, and that figure is expected to rise.

 3. Major threats to marine systems include coastal development, degradation of wetlands and estuaries, over-fishing, non-point and point source pollution, habitat destruction, invasive species, and climate change.

 **CASE STUDY**: **The Chesapeake Bay - an estuary in trouble**.

Chesapeake Bay is the largest estuary in the United States. Population pressures and pollution have led to severe environmental problems in the region. An integrated program involving diverse groups has been effective in recent years at alleviating the severity of some of these pressures. Nevertheless, a recent decline in funding has slowed progress and environmental problems remain. New efforts to revitalize the project are promising.

**8-4 Why are freshwater ecosystems important?**

A. Freshwater life zones include standing (lentic) bodies—such as lakes, ponds, and wetlands—and flowing (lotic) systems such as streams and rivers.

1. Lakes are large natural bodies of standing water found in depressions.

1. Rainfall, runoff, groundwater seepage and stream drainage feed lakes.

2. Generally consist of four distinct zones depending on depth and distance from shore

1. The littoral zone
2. The limnetic zone
3. The profundal zone
4. The benthic zone
5. Surface water is precipitation that does not infiltrate the ground or evaporate.

1. Runoff is surface water that flows into streams and rivers, and the area it drains is called a watershed or drainage basin.

1. Three aquatic life zones, each with different conditions, can be identified along stream flow.

1. The source zone

2. The transition zone

3. The floodplain zone

 **CASE STUDY**: **River deltas and coastal wetlands - vital components of natural capital now in jeopardy**.

Coastal deltas and wetlands provide protection against flooding. When these areas are degraded, the effects of storm events can be intensified. Many deltas are shrinking rather than being maintained, because the sediments that normally build them are trapped behind dams upstream. Much of the city of New Orleans is now below sea level for this reason. Levees offer a temporary solution but will usually be breached by a strong storm. Climate change also suggests that sea level will be rising further. We now understand these processes, but the question is whether or not we will apply them to the systems that are at risk.

1. Inland wetlands cover the land for a part of all of each year. Wetlands include swamps, marshes, prairie potholes, floodplains, and arctic tundra in summer.

 1. Wetlands provide a variety of ecosystem services, including filtering waste, reducing flooding, replenishing stream flows, recharging aquifers, maintaining biodiversity, supplying valuable products, and providing recreation opportunities.

**8-5 How have human activities affected freshwater ecosystems?**

A. Human activities have four major impacts on freshwater systems.

1. Dams, diversions of canals fragment ~60% of world’s large rivers and destroy habitats.

2. Flood control dikes and levees alter rivers and destroy aquatic habitats.

3. Cities and farmlands add pollutants.

4. Many inland wetlands have been drained or altered.

**Teaching Tips**

**Large Lecture Courses:**

Ask the members of the class to brainstorm ways in which they may inadvertently be putting pollutants into their waterways. List these on the board for reference. As the students run out of suggestions, question them Socratically about their activities and the pollution that is generated around them. Bring up such activities as fertilizing the lawn and garden or washing the car. Draw the connection between general classes of pollutants and everyday activities that often seem benign.

**Smaller Lecture Courses:**

Explore the manner in which the local community augments or hinders the functioning of the hydrologic system, and in particular the extent to which the way we live determines how much water runs off versus infiltrating. Explain the ramifications of both scenarios, in terms of flooding, recharging groundwater resources, cleaning the water of toxins and pollutants, etc. It may be valuable if the technology is available in your classroom to project a Google Earth map of the surrounding region. This will help students visualize the extent to which community design dictates the flow of water. Perhaps there is a levee system, a dam, or a reservoir in your area. If not, you might focus on the relative abundance of pavement versus vegetated open space to draw conclusions about what this entails for the hydrologic cycle.

### Key Terms

aquatic life zones

benthos

coastal wetland

coastal zone

cultural eutrophication

decomposers

drainage basin

eutrophic lake

freshwater

inland wetlands

intertidal zone

lakes

marine

mesotrophic lake

nekton

oligotrophic lakes

open sea

plankton

runoff

saltwater

surface water

turbidity

watershed

### Term Paper Research Topics

1. Aquatic life zones: coastal zones, beaches, coastal wetlands, coral reefs, the abyssal zone.

2. Freshwater life zones: lakes, streams, and rivers.

3. Seasonal turnover in lakes.

4. What is life like at hydrothermal vents in the deep ocean?

5. Wetlands protection.

6. Prevention of beach erosion

7. Coastal cleanup strategies.

8. Endangered species of the coast.

9. What can be done to prevent coral bleaching?

**Discussion Topics**

1. In what ways do humans disrupt the hydrologic cycle? What are the impacts of these disruptions?

2. What are the ecological contributions of the oceans?

3. What is the ecological significance of coral reefs? Are there any reefs in your area? If not, why should you be concerned about them?

4. What are the valuable ecological functions performed by wetlands? What are some environmental problems associated with coastal and inland wetlands? Where could you find an intact wetland in your area?

5. What kinds of activities lead to eutrophication in lakes? Do you contribute to this process in any way?

6. Can you define or roughly delineate the watershed in your area? Why is it important to take a watershed approach to managing freshwater systems?

7. Should we retreat from the beach? Should houses built on barrier beaches have access to insurance?

8. Is your water supply affected by spring and fall turnovers?