



## Chapter 6 Aquatic Biodiversity



### “It’s A Small World After All”

#### Outline

##### Aquatic Environments

- A. Saltwater and freshwater aquatic zones cover about 71% of the earth’s surface. These are the equivalent of terrestrial biomes.
- 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) they may be single-celled protozoa to large invertebrates such as jellyfish, and ultraplankton that are no more than 2 micrometers wide and are photosynthetic bacteria.
  2. Ultraplankton may be responsible for as much as 70% of the primary productivity near the ocean surface.
  3. Nekton is a second group of organisms. These are fish, turtles and whales
  4. Benthos are bottom dwellers, a third group of organisms, barnacles, oysters, worms, lobsters and crabs are examples of benthos organisms.
  5. Decomposers are a fourth group. These organisms break down organic matter into simple nutrients for use by producers.
- D. Three layers of aquatic life zones can be used: surface, middle, bottom.
  1. Temperature, sunlight availability, dissolved oxygen, and nutrient availability determine types and numbers of producers found in these zones.
  2. Euphotic zone describes the upper layer where sunlight can penetrate. Clouding or excessive algal growth reduces depth of euphotic zone.
  3. Dissolved oxygen levels higher near surface due to photosynthesis in this area.
  4. O<sub>2</sub> levels are lower in deeper, dark layers due to aerobic respiration and because less O<sub>2</sub> gas dissolves in deeper and colder water.
  5. Open oceans tend to have limited amounts of nitrates, phosphates, iron, and other nutrients that limit productivity.
  6. Shallow waters are generally well supplied with nutrients for growth.
  7. Deep dwelling species depend on animal and plant material that die/ float to bottom. Large fish are vulnerable to over fishing depletion.

##### Saltwater Life Zones

- A. Oceans have two major life zones: the coastal zone and the open sea.
- B. The coastal zone interacts with the land so, is much 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. There is ample sunlight and nutrients flow from land and wind/currents distribute them.
  3. The coastal zone extends from the high-tide mark on land to the edge of the continental shelf.
  4. Estuaries and coastal wetlands are subject to tidal rhythms, runoff from land, and seawater that mixes with freshwater and nutrients from rivers and streams.
  5. Mangrove forest swamps grow in sheltered regions of tropical coasts. They collect mud and anaerobic sediment.
  6. Coastal wetlands/ estuaries make nutrients available due to constant stirring of bottom sediment.
  7. These areas filter toxic pollutants, excess plant nutrients, reduce storm damage and provide nursery sites for aquatic species.
  8. Humans are destroying/degrading these ecosystems; 1/3 have already been lost.
- C. Organisms living in the intertidal zone have adapted ways 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.
  1. The islands help protect the mainland, estuaries, and coastal wetlands from heavy storm

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- damage.
2. People want to live on these islands, but they are subject to damage. In spite of this, almost one-fourth of barrier islands are developed.
  3. Sand is constantly shifting due to winds and parallel currents along the islands.
  4. Undisturbed beaches have one or more rows of sand dunes on them. Grass roots hold the sand in place and the dune is a first line of defense against storms. It is safer to build behind the second set of dunes if any building occurs.
  5. Developers want to build on the islands and do not consider the protective services that the dunes provide. Large storms can and have swept away or severely damaged seaside buildings.
  6. Governments often provide funds for rebuilding and insurance at fairly low rates for building on the dunes.
  7. Some people think that persons building in such risky places should accept all responsibility for repair or replacement due to storm damage.
- F. Coral reefs in shallow coastal zones of tropical and subtropical oceans support a very diverse, complex ecosystem.
1. They grow slowly and are vulnerable to damage.
  2. They thrive in clear, warm, fairly shallow water with a high salinity. The ideal water temperature is between 18-30°C and will bleach if the water warms above this by so much as 1°C.
  3. Severe storms, freshwater floods, and invasions of predatory fish adversely affect the reefs. They have survived natural disturbances for a long geologic history.
  4. The greatest threats today are due to sediment runoff and other human activities. Coral reef systems may not have enough time to adapt to these rapidly changing conditions.
  5. There are indications that recovery is possible when restrictions are imposed and pollution is reduced.
- G. The open sea is divided into three vertical zones based primarily on penetration of light.
1. The euphotic zone is lighted, has floating phytoplankton carrying on photosynthesis and has low nutrient levels except at upwellings.
  2. Dissolved oxygen level is high.
  3. Large, fast-swimming predatory fish like swordfish, shark and bluefin tuna live in this zone.
  4. The bathyal zone is the dimly lit middle zone; no producers are in this zone. Zooplankton and smaller fish live in this zone.
  5. The abyssal zone is dark, very cold with little dissolved oxygen. The nutrients on the ocean floor occult support about 98% of species living in the ocean.
  6. Organisms in this area are deposit feeders, or filter feeders.
  7. Hydrothermal vents are present in some areas with specialized bacteria feed on chemical nutrients and are food for other organisms
  8. Low average primary productivity and NPP occurs, but oceans are so large they make the largest contribution to NPP overall.
- H. About 40% of the world population lives along coasts. Over half of US population lives with 62 miles of the coast.

#### Freshwater Life Zones

- A. Freshwater life zones contain less than 1% by volume of salt. These zones include standing (lentic) bodies such as lakes, ponds and wetlands, and flowing (lotic) systems such as streams and rivers.
- B. Lakes are large natural bodies of standing water found in depressions.
1. Rainfall, melting snow, stream drainage feed lakes.
  2. Generally consist of four distinct zones depending on depth and distance from shore.
    - a. Littoral zone is open, sunlit surface water away from shore and is the most productive area for food and oxygen production.
    - b. Profundal zone is deep open water too dark for photosynthesis. Oxygen levels are lower.
    - c. Benthic zone consists of decomposers and detritus feeders. Fish swim from one zone to another. Sediment washing and dropping detritus feed this area.
- C. Stratification of water occurs in deep temperate lakes into temperature zones, no mixing occurs.
- D. During fall and spring have turnover of water that brings up nutrients, reoxygenates bottom levels,

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- and evens out water temperature.
- E. Lakes are described with reference to their plant nutrients.
1. An oligotrophic lake is one that has been newly formed, has a small supply of plant nutrients. They are often deep, crystal-clear blue or green water with low net primary productivity.
  2. A eutrophic lake has a large or excessive supply of nutrients. Typically are shallow with murky brown or green water with low visibility and high net primary productivity. Cultural eutrophication accelerates this process.
  3. Lakes between these two extremes are called mesotrophic lakes.
- F. Waters flowing from mountains to sea create different aquatic conditions and habitats.
1. Surface water does not sink into the ground.
  2. Runoff is surface water that flows into streams and rivers and the area it drains is called a watershed or drainage basin.
- G. Three aquatic life zones, each with different conditions can be identified along stream flow.
1. The source zone is narrow and fast moving. It dissolves large amounts of oxygen from air and most plants are attached to rocks. Light is available, but is not very productive.
  2. The transition zone forms wider, deeper streams, flow down gentler sloped. The water is warmer, with more nutrients and support more producers, but have slightly lower dissolved oxygen.
  3. The floodplain zone has wider, deeper rivers. Water temperature is warmer, less dissolved oxygen is present and flow is slower. There may be fairly large numbers of producers such as algae, cyanobacteria, and rooted plants.
- H. Streams are fairly open ecosystems and receive many nutrients from surrounding lands.
- I. Farms, power plants, cities and recreation areas are often found in floodplains. This also increases excessive nutrient input, and pollutant input into the river system.
- J. 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. Scientists also use soil composition and plant life to define whether a particular area is a wetland.
  2. Wetlands provide a number of free ecological services such as filtering toxic wastes/pollutants, absorbing/storing excess water from storms and providing habitats for a variety of species.
- K. Human activities have four major impacts on freshwater systems.
1. Dams, diversions, of canals fragment ~60% of world’s large rivers and destroys habitats.
  2. Flood control dikes and levees alter rivers and destroy aquatic habitats.
  3. Cities and farmlands add pollutants.
  4. Wetlands have been drained or covered with buildings. The U.S. has lost more than 50% of its wetlands since the 1600’s.
  5. These systems are able to recover when destructive practices are stopped or reduced

### Summary

1. The basic types of aquatic life zones are the surface, middle, and bottom layers. The life in aquatic life zones is influenced by temperature, access to sunlight for photosynthesis, dissolved oxygen content, and availability of nutrients.
2. The major types of saltwater life zones are the coastal zone and the open sea. Coastal ecosystems contain estuaries, wetlands, and mangrove swamps. Because of their close proximity to man’s activities, they are under constant assault from water pollution, industrial run-off, construction and soil erosion, agricultural pesticides flowing into rivers and streams, and aquaculture farming. The open sea contains the euphotic zone that is the lighted upper zone of the ocean. The bathyal zone is in the middle and is dimly lit. The lowest zone, the abyssal zone, is dark and very cold. But all are being undermined by human activities: over-harvesting, oil spills, filling-in of wetland areas, agricultural and industrial development and pollution, rising sea levels, and careless fishing/trawling techniques.
3. The major types of freshwater life zones are lakes, wetlands and rivers. Human activities, such as dams or canals; flood control levees and dikes; and industrial, urban, agricultural pollutants all affect

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the flow and health of freshwater zones. Much of U. S. wetlands have been drained and filled to farm and/or to construct homes and businesses. These actions increase flood potential and encourage droughts. People overfish the waters, pollute the streams, rivers, and lakes and dump excessive nutrients from pesticides and waste lots into the fresh water sources.

4. We must protect aquatic life zones from the pollutants, water controls, and deterioration that we press upon them every day.

### Objectives

1. Summarize the distribution of light, salt, and temperature in different aquatic life zones.
2. Evaluate the significance of the ecological contributions of the oceans.
3. Briefly describe the characteristics and ecological significance of coral reefs. Describe environmental and economic problems of coral reefs.
4. Distinguish between coastal and inland wetlands. Describe the ecological functions performed by wetlands. Describe environmental problems associated with coastal and inland wetlands.
5. List and compare the four zones of a lake. Distinguish between oligotrophic and eutrophic lakes. Describe stratification and a turnover in a lake.
6. Define *watershed*. List and distinguish the three zones of a river system.

### **Key Terms (Terms are listed in the same font style as they appear in the text.)**

<p><i>abyssal zone</i> (p. 135)  <i>arctic tundra</i> (p. 140)  <i>barrier beaches</i> (p. 133)  <i>barrier islands</i> (p. 133)  <i>bathyal zone</i> (p. 135)  <i>benthic zone</i> (p. 137)  <b>benthos</b> (p. 128)  <b>coastal wetland</b> (p. 129)  <b>coastal zone</b> (p. 129)  <i>continental shelf</i> (p. 129)  <i>coral bleaching</i> (p. 126)  coral reefs (p. 133)  <b>cultural eutrophication</b> (p. 138)  <b>decomposers</b> (p. 128)  <i>deposit feeders</i> (p. 135)  <b>drainage basin</b> (p. 138)  <b>estuary</b> (p. 129)  <i>euphotic zone</i> (p. 135)  <b>eutrophic lake</b> (p. 138)  <i>filter feeders</i> (p. 135)  <i>floodplain zone</i> (p. 138)  <i>floodplains</i> (p. 140)  <i>flowing (lotic)</i> (p. 136)  <i>freshwater</i> (p. 127)  <i>standing (lentic)</i> (p. 136)  <b>surface water</b> (p. 138)  <i>swamps</i> (p. 140)  <i>tides</i> (p. 131)  <i>transition zone</i> (p. 138)</p>	<p><i>freshwater life zones</i> (p. 136)  <b>inland wetlands</b> (p. 140)  <b>intertidal zone</b> (p. 131)  <b>lakes</b> (p. 136)  <i>limnetic zone</i> (p. 136)  <i>littoral zone</i> (p. 136)  <i>mangrove forests</i> (p. 129)  <i>marshes</i> (p. 140)  <b>mesotrophic lake</b> (p. 138)  <b>nekton</b> (p. 128)  <b>oligotrophic lake</b> (p. 138)  <b>open sea</b> (p. 135)  <i>overturns</i> (p. 137)  <i>phytoplankton</i> (p. 128)  <b>plankton</b> (p. 128)  <i>polyps</i> (p. 126)  <i>prairie potholes</i> (p. 140)  <i>profundal zone</i> (p. 137)  <i>rocky shores</i> (p. 132)  <b>runoff</b> (p. 138)  <i>salinity</i> (p. 127)  <i>saltwater (marine)</i> (p. 127)  <i>sandy shores</i> (p. 133)  <i>seasonal wetlands</i> (p. 140)  <i>source zone</i> (p. 138)  <b>ultraplankton</b> (p. 128)  <b>watershed</b> (p. 138)  <i>xooxanthellae</i> (p. 126)  zooplankton (p. 128)</p>
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