

Chapter 8

Aquatic Biodiversity



If there is magic on this planet, it is contained water. – Loren Eiseley

Core Case Study: Why Should We Care about Coral Reefs?

- Biodiversity
- Formation
 - Tiny animals (polyps) and algae have mutualistic relationship
 - Polyps secrete calcium carbonate shells, which become coral reefs



CORAL REEFS: ECOLOGICAL & ECONOMIC SERVICES

Important ecological and economic services

- Moderate atmospheric temperatures
- Act as natural barriers protecting coasts from erosion
- Provide habitats
- Support fishing and tourism businesses
- Provide jobs and building materials
- Studied and enjoyed

CORAL REEFS: DEGRADATION & DECLINE

Degradation and decline

- Coastal development
- Pollution
- Overfishing
- Warmer ocean temperatures leading to coral bleaching: kill algae and thus the polyps
- Increasing ocean acidity



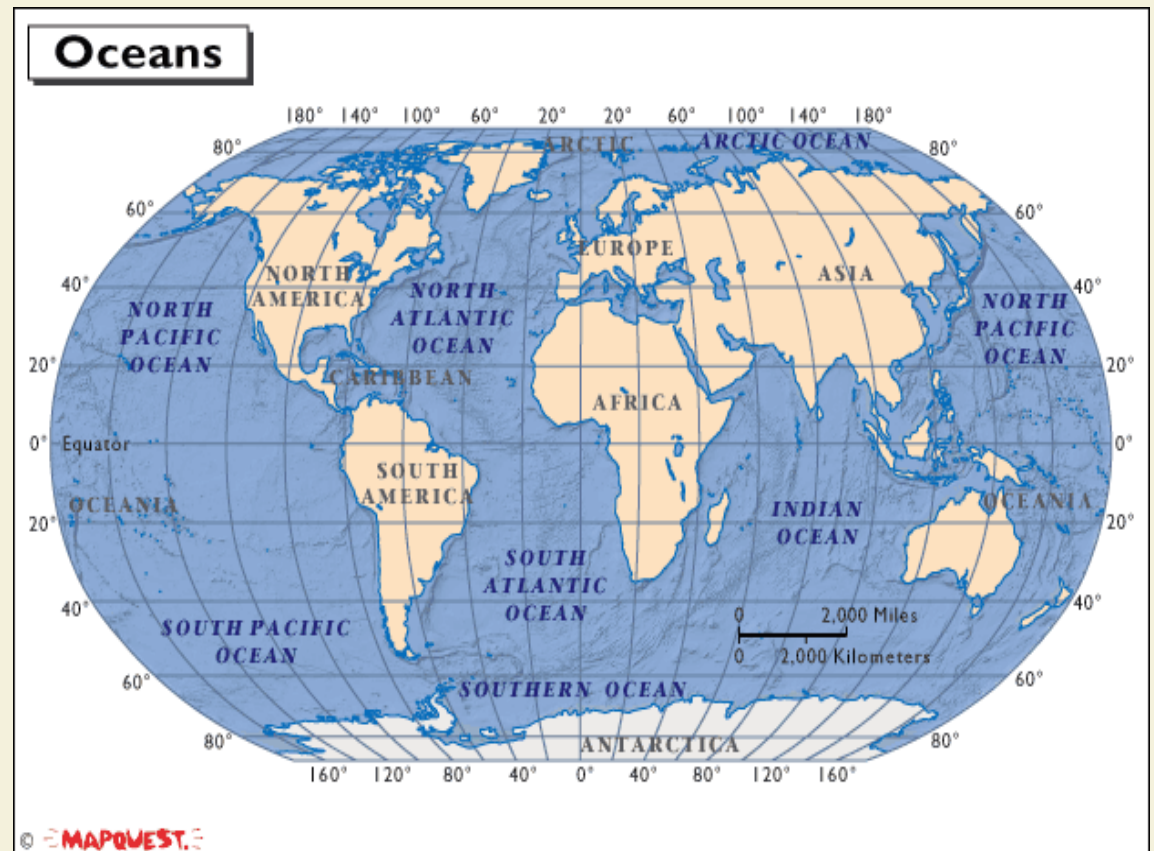
8-1 What Is the General Nature of Aquatic Systems?

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

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

Most of the Earth Is Covered with Water

- Saltwater: global ocean divided into 4 areas
 - Atlantic
 - Pacific
 - Arctic
 - Indian
- Freshwater



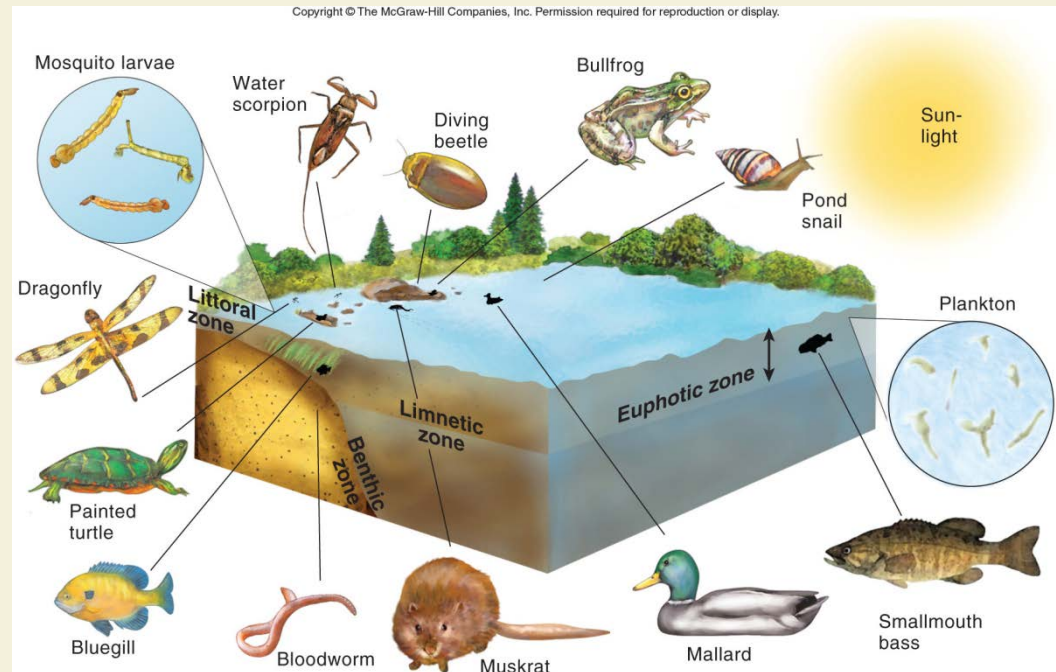
AQUATIC LIFE ZONES

Saltwater life zones (marine life zones)

- Oceans and estuaries
- Coastlands and shorelines
- Coral reefs
- Mangrove forests

Freshwater life zones

- Lakes
- Rivers and streams
- Inland wetlands



The Ocean Planet



Ocean hemisphere



Land-ocean hemisphere

Aquatic Systems



Fig. 8-3, p. 170

AQUATIC SPECIES: TYPES OF PLANKTON

Plankton: free floating

- Phytoplankton
 - Primary producers for most aquatic food webs
- Zooplankton
 - Primary and secondary consumers
 - Single-celled to large invertebrates like jellyfish
- Ultraplankton
 - Tiny photosynthetic bacteria



Most Aquatic Species Live in Top, Middle, or Bottom Layers of Water

Nekton

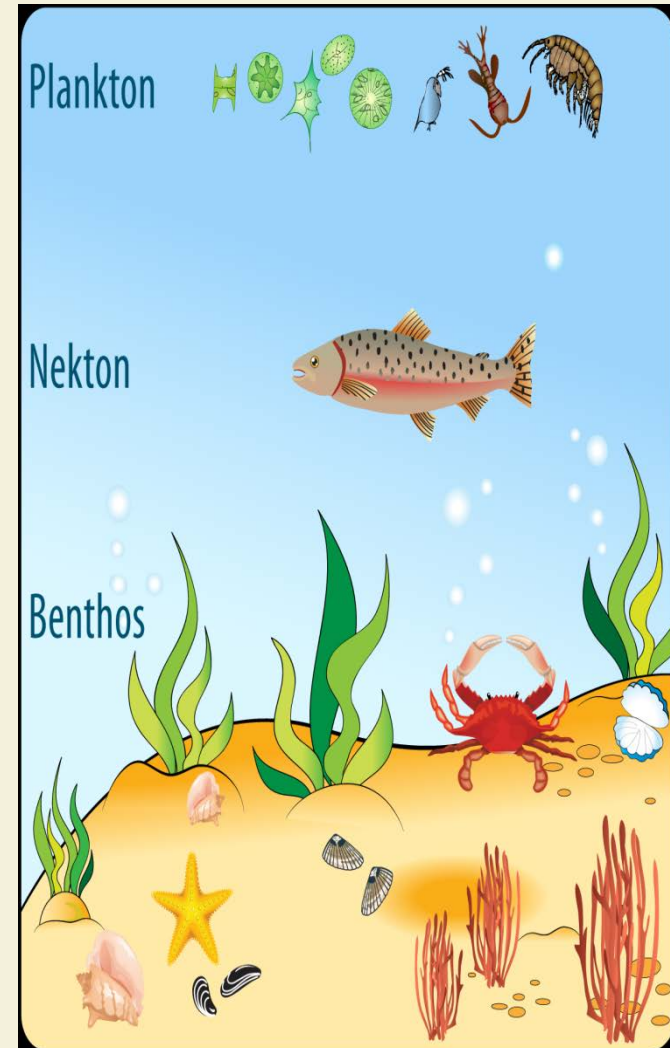
- Strong swimmers: fish, turtles, whales

Benthos

- Bottom dwellers: oysters, sea stars, clams, lobsters, crabs

Decomposers

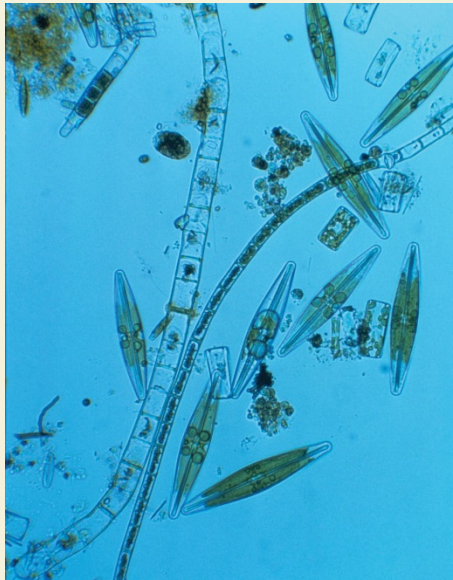
- Mostly bacteria



KEY FACTORS THAT DETERMINE TYPES & NUMBERS OF ORGANISMS

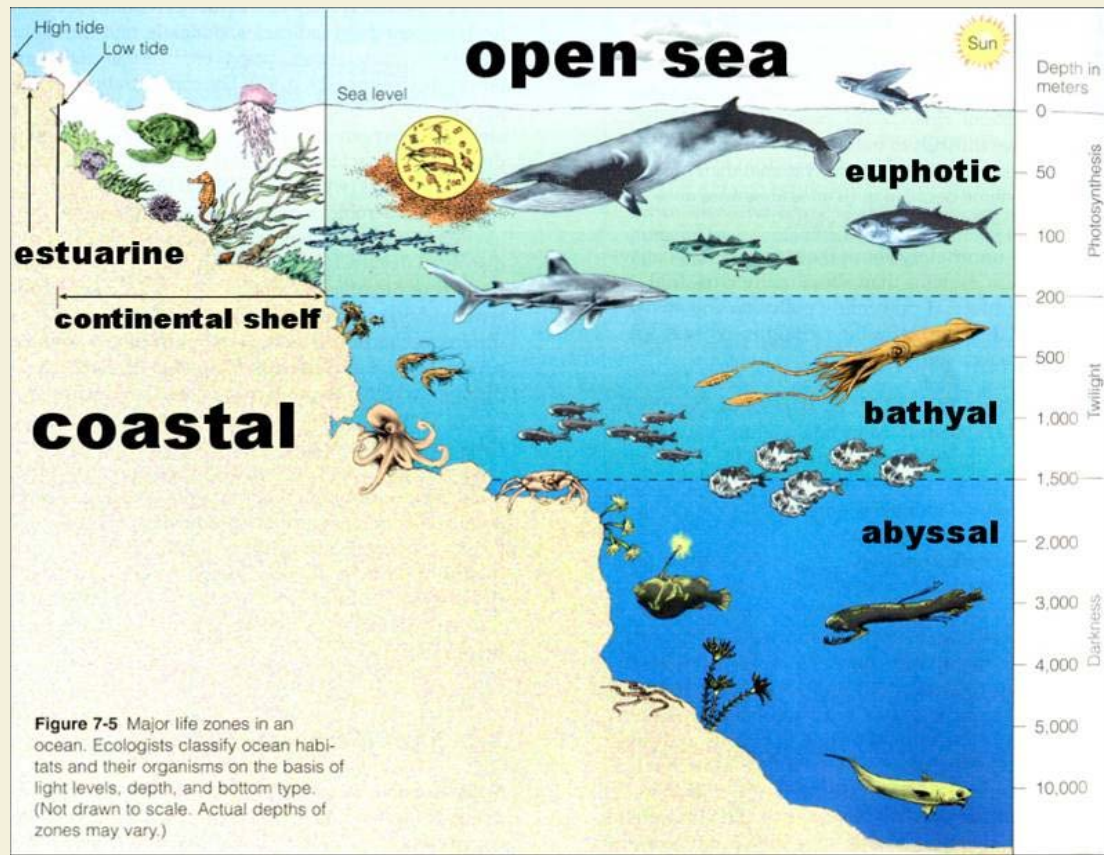
- Key factors in the distribution of organisms
 - Temperature
 - Dissolved oxygen content
 - Availability of food
 - Availability of light and nutrients needed for photosynthesis in the euphotic (photic) zone
- **Turbidity**: degree of cloudiness in water
 - Inhibits photosynthesis

Four Types of Aquatic Life Forms



8-2 Why Are Marine Aquatic Systems Important?

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



Oceans Provide Vital Ecological and Economic Resources

- Estimated \$12 trillion per year in goods and services
- Reservoirs of diversity in three major life zones
 1. Coastal zone
 - Warm, nutrient rich, shallow
 - Shore to edge of continental shelf
 - Usually high NPP from ample sunlight and nutrients
 2. Open sea
 3. Ocean bottom

Major Ecological and Economic Services Provided by Marine Systems

Natural Capital

Marine Ecosystems

Ecological Services

Climate moderation

CO₂ absorption

Nutrient cycling

Waste treatment

Reduced storm impact
(mangroves, barrier islands,
coastal wetlands)

Habitats and nursery areas

Genetic resources and
biodiversity

Scientific information



Economic Services

Food

Animal and pet feed

Pharmaceuticals

Harbors and
transportation routes

Coastal habitats for
humans

Recreation

Employment

Oil and natural gas

Minerals

Building materials

Major Life Zones and Vertical Zones in an Ocean

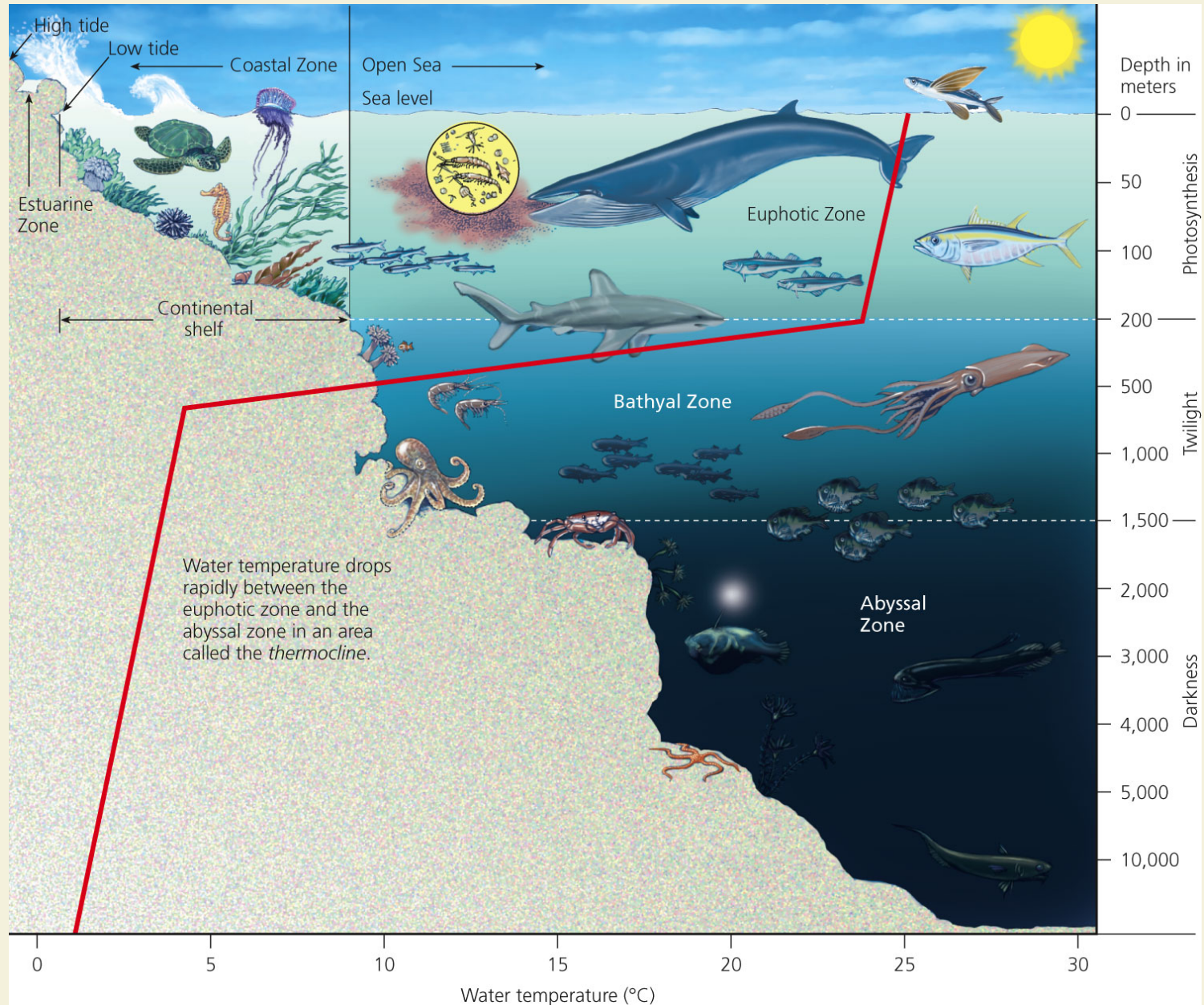


Fig. 8-6, p. 173

Estuaries and Coastal Wetlands Are Highly Productive

Estuaries and coastal wetlands

- Where rivers meet the sea
- Seawater mixes with freshwater
- Very productive ecosystems: high nutrient levels
- River mouths
- Inlets
- Bays
- Sounds
- Salt marshes
- Mangrove forests

View of an Estuary from Space



Fig. 8-7, p. 173

Coastal Marsh Ecosystem

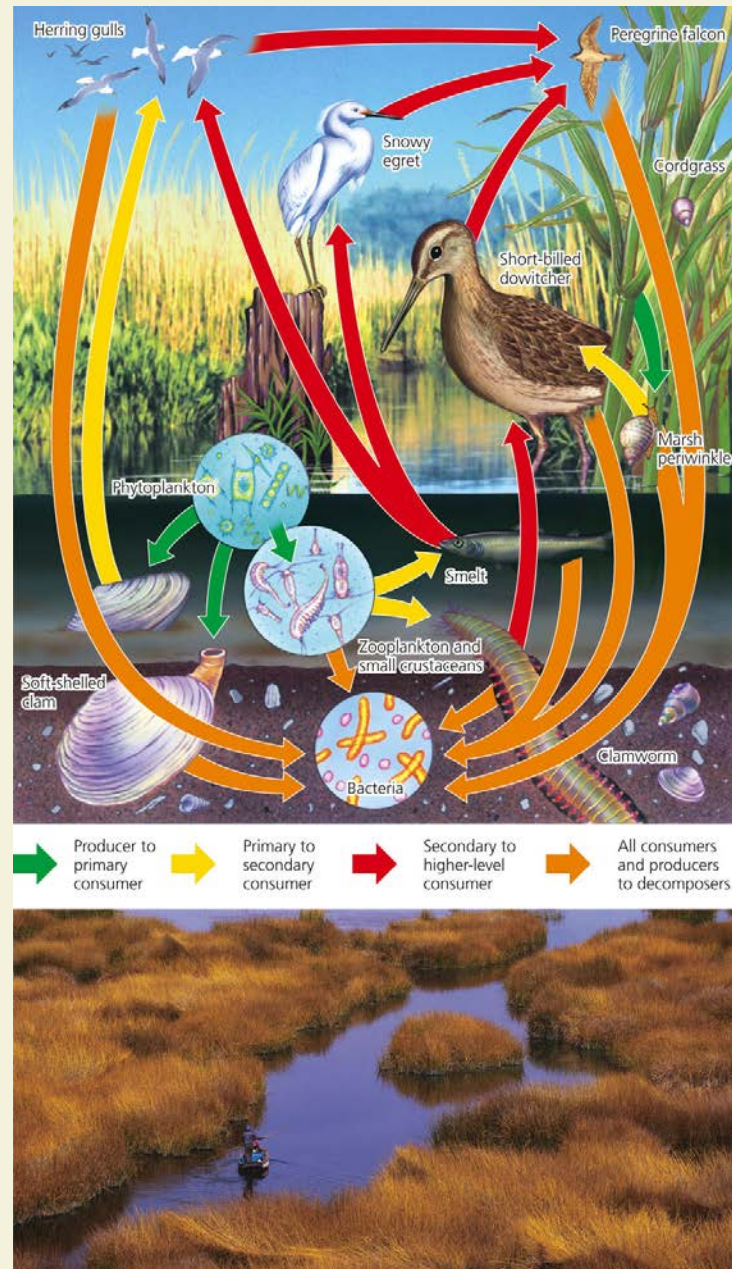


Fig. 8-8, p. 174

Estuaries and Coastal Wetlands: Seagrass Beds & Mangroves

- Seagrass Beds
 - Grow underwater in shallow areas
 - Support a variety of marine species
 - Stabilize shorelines
 - Reduce wave impact
- Mangrove forests
 - Along tropical and subtropical coastlines
 - 69 different tree species that grow in saltwater

Sea Grass Bed Organisms



Fig. 8-9, p. 174

Mangrove Forest in Australia



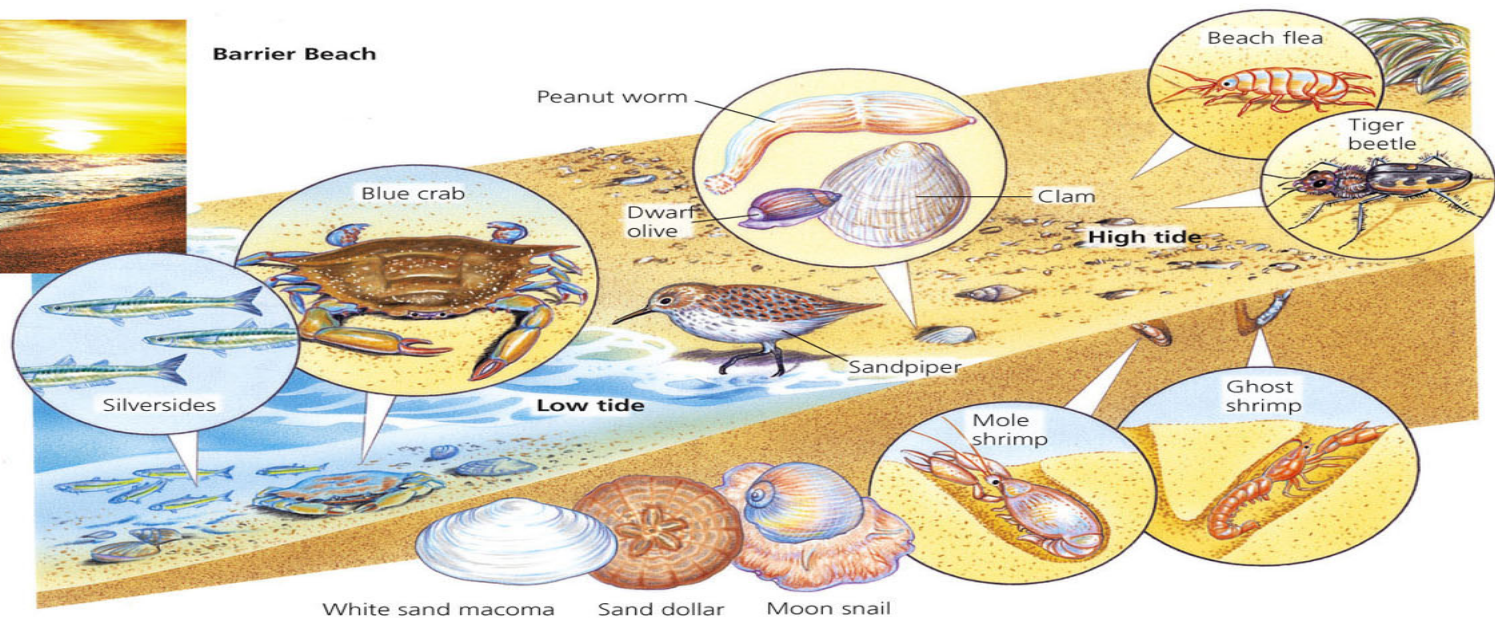
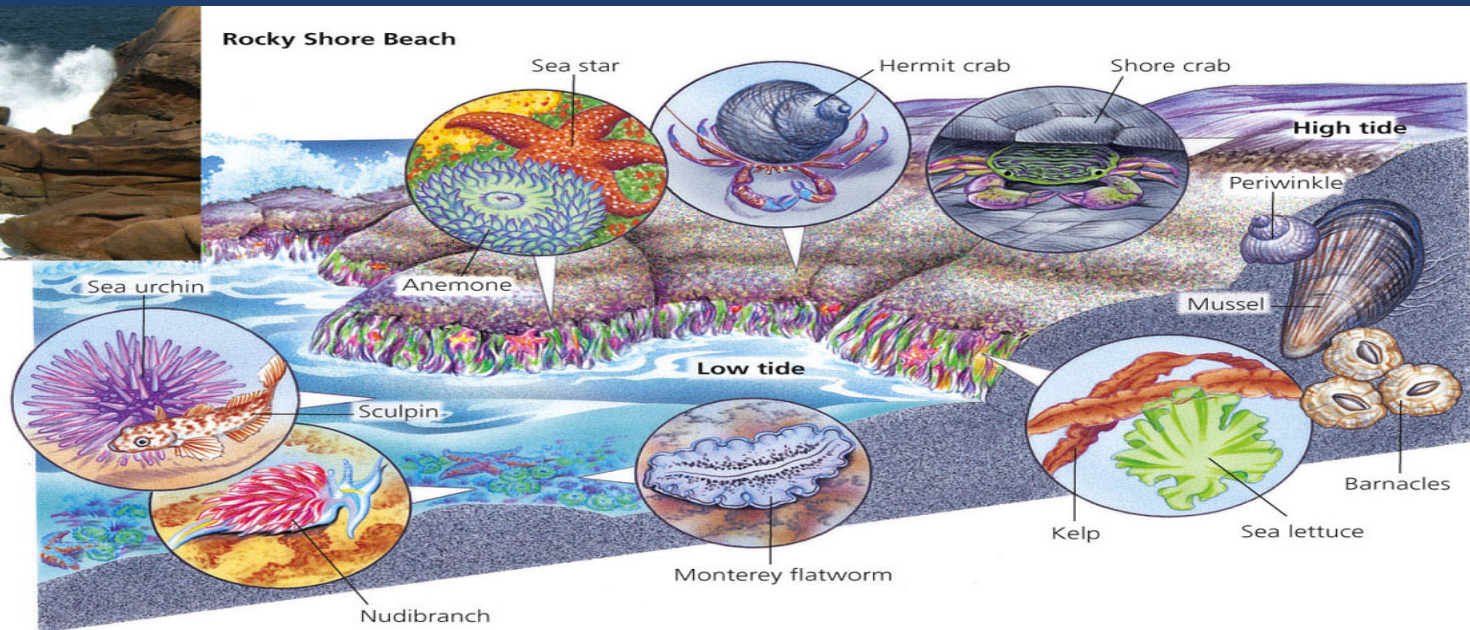
Estuaries and Coastal Wetlands Ecological & Economic Services

- Coastal aquatic systems maintain water quality by filtering
 - Toxic pollutants
 - Excess plant nutrients
 - Sediments
- Absorb other pollutants
- Provide food, timber, fuelwood, and habitats
- Reduce storm damage and coast erosion

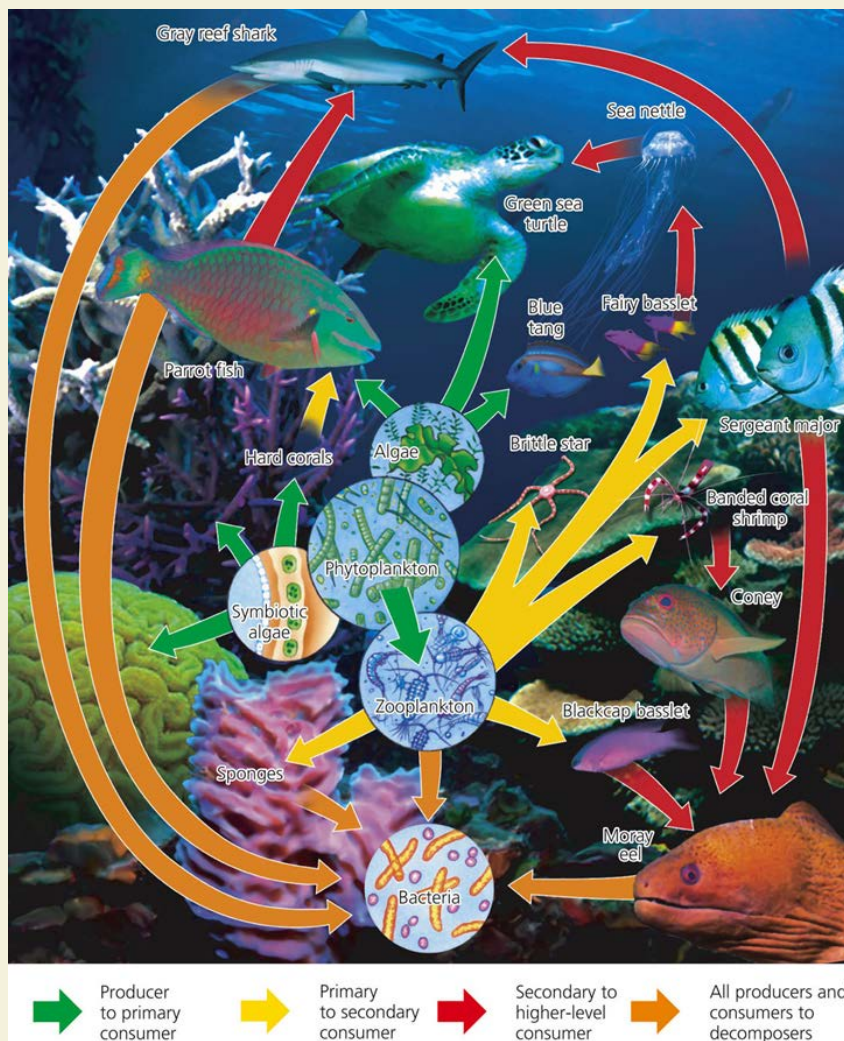
Rocky and Sandy Shores Host Different Types of Organisms

- **Intertidal zone**
 - Rocky shores
 - Sandy shores: barrier beaches
- Organism adaptations necessary to deal with daily salinity and moisture changes
- Importance of sand dunes

Living between the Tides



Coral Reefs Are Amazing Centers of Biodiversity



- Marine equivalent of tropical rain forests
- Habitats for one-fourth of all marine species

The Open Sea and Ocean Floor Host a Variety of Species (1)

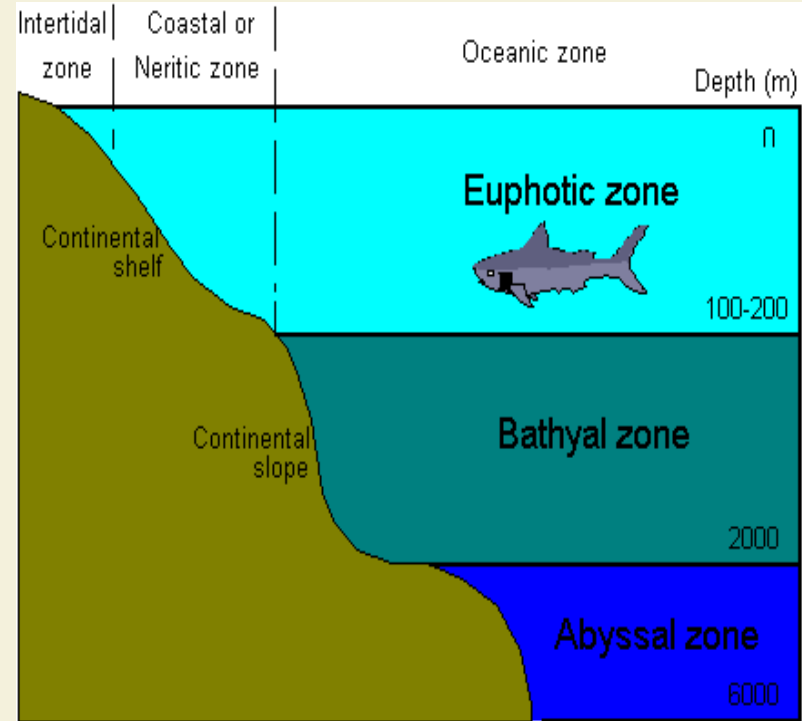
- Three vertical zones of the open sea

1. Euphotic zone

- Phytoplankton
- Nutrient levels low
- Dissolved oxygen levels high

2. Bathyal zone

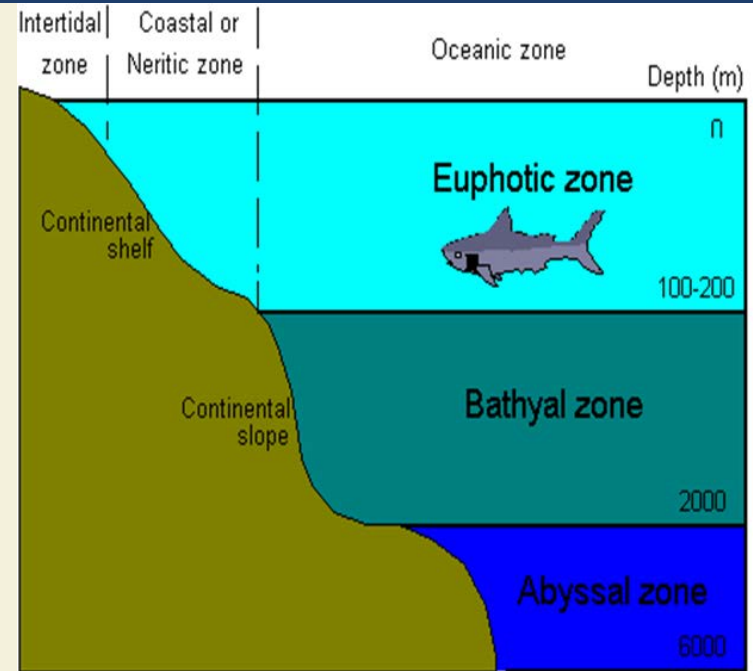
- Dimly lit
- Zooplankton and smaller fishes



The Open Sea and Ocean Floor Host a Variety of Species (2)

3. Abyssal zone

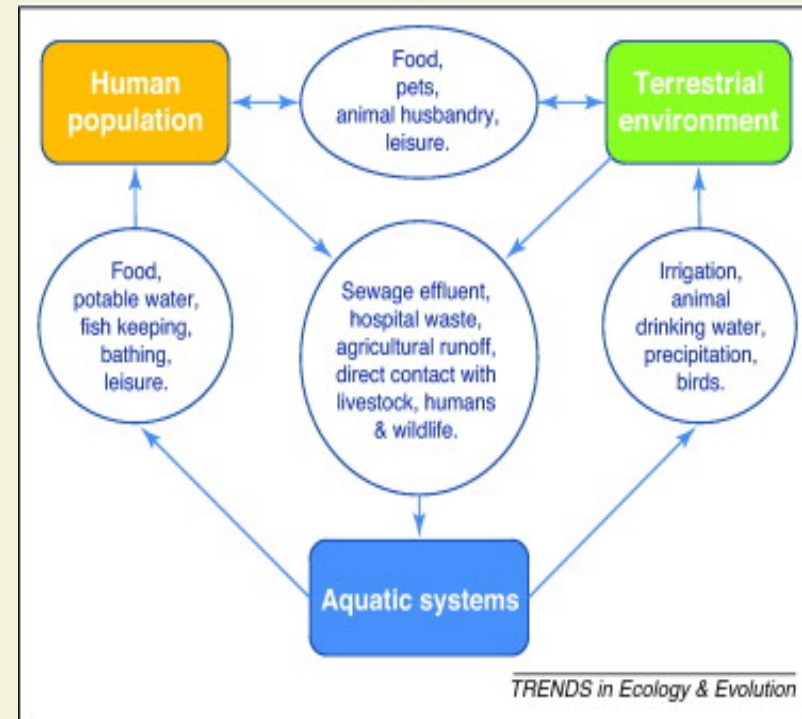
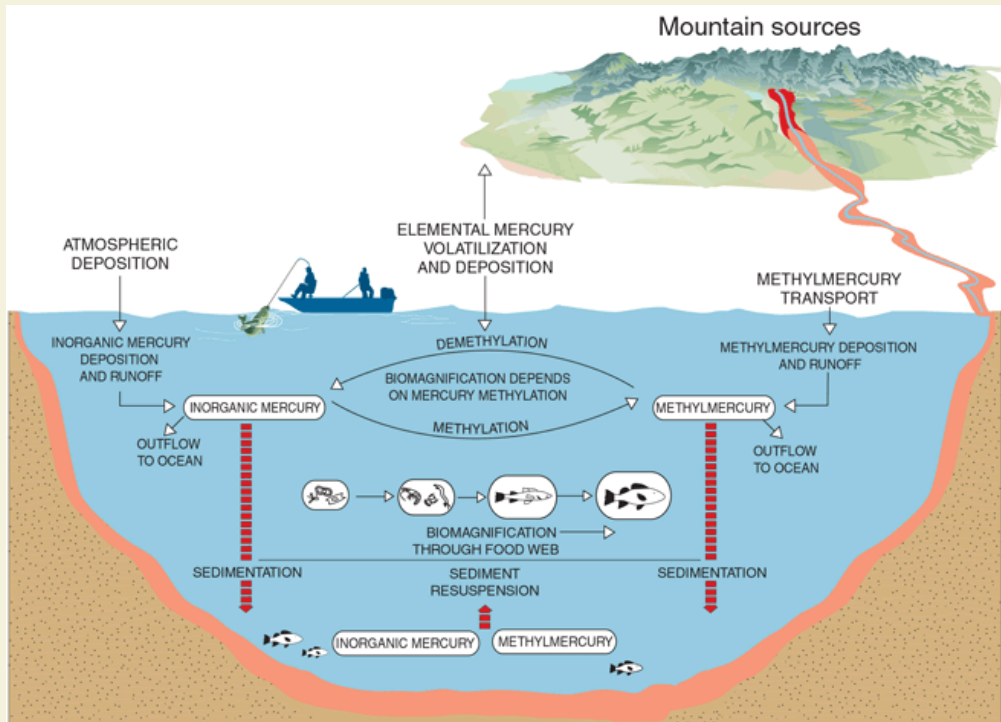
- Dark and cold
- High levels of nutrients
- Little dissolved oxygen
- Deposit feeders
- Filter feeders



- Upwelling brings nutrients to euphotic zone
- Primary productivity and NPP

8-3 How Have Human Activities Affected Marine Ecosystems?

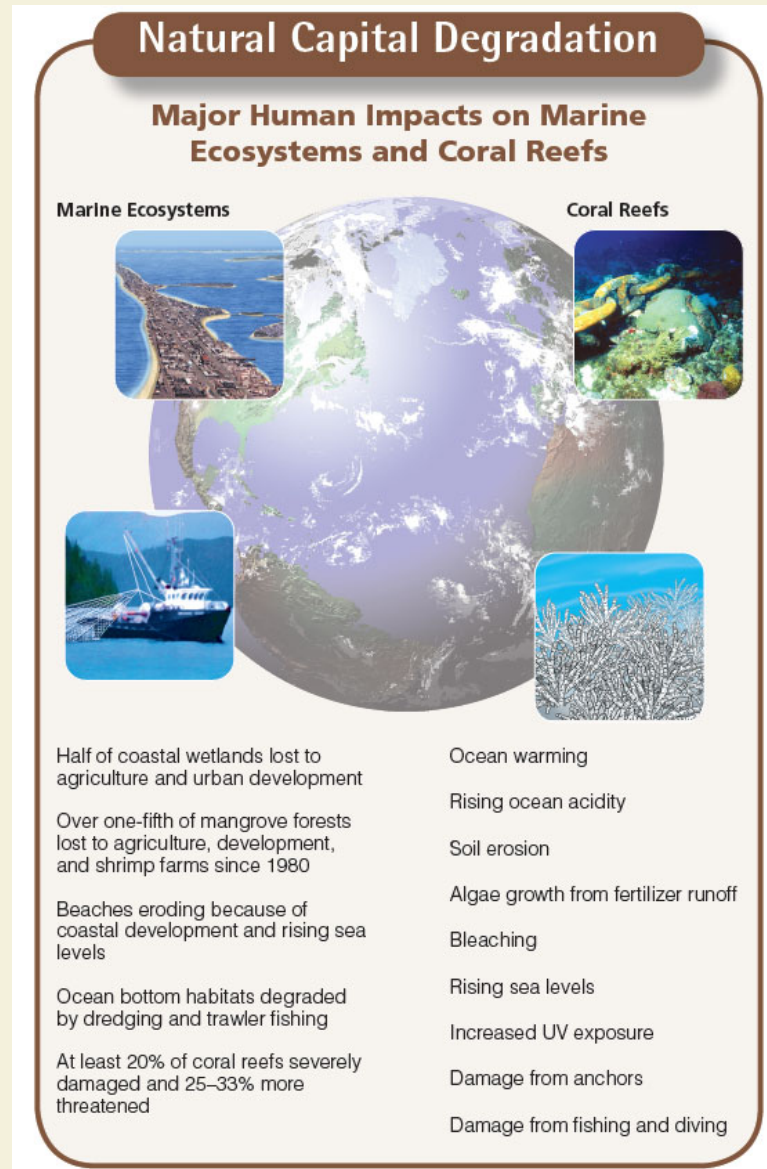
- **Concept 8-3** Human activities threaten aquatic biodiversity and disrupt ecological and economic services provided by saltwater systems.



Human Activities Are Disrupting and Degrading Marine Systems

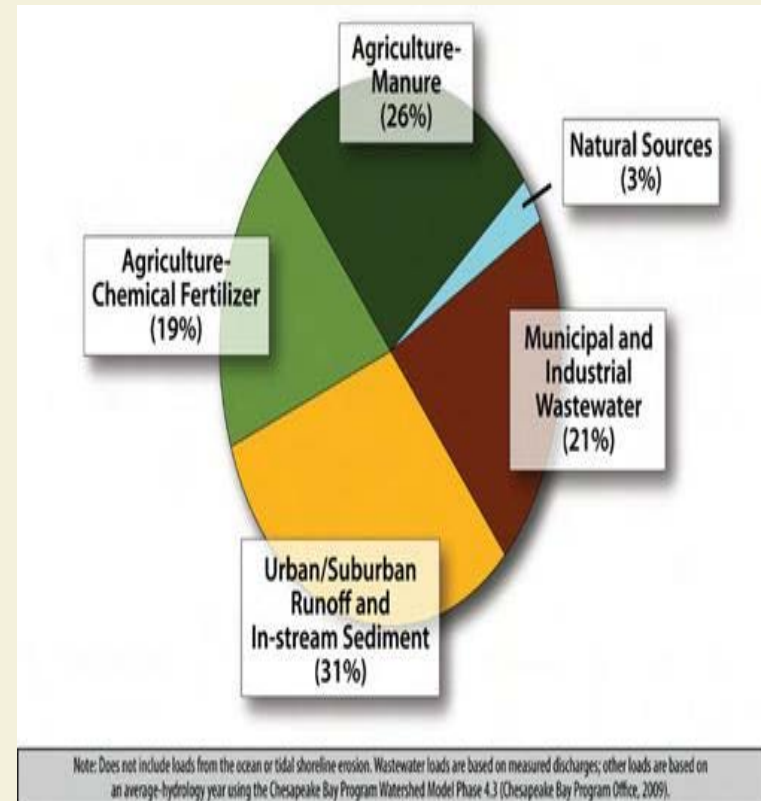
- Major threats to marine systems
 - Coastal development
 - Overfishing
 - Use of fishing trawlers
 - Runoff of nonpoint source pollution
 - Point source pollution
 - Habitat destruction
 - Introduction of invasive species
 - Climate change from human activities
 - Pollution of coastal wetlands and estuaries

Major Human Impacts on Marine Ecosystems and Coral Reefs



Case Study: The Chesapeake Bay—an Estuary in Trouble (1)

- **Largest estuary in the US; polluted since 1960**
- **Human population increased**
- **Point and nonpoint sources raised pollution**
- **Phosphate and nitrate levels too high**
- **Excess sediments from runoff and decreased vegetation**



Case Study: The Chesapeake Bay—an Estuary in Trouble (2)

- Oysters, a keystone species, greatly reduced
- 1983: Chesapeake Bay Program
 - Integrated coastal management with local, state, federal governments and citizens' groups
- 2008 update:
 - 25 years and \$6 billion
 - Program met only 21% of goals
 - Water quality “very poor”

Chesapeake Bay

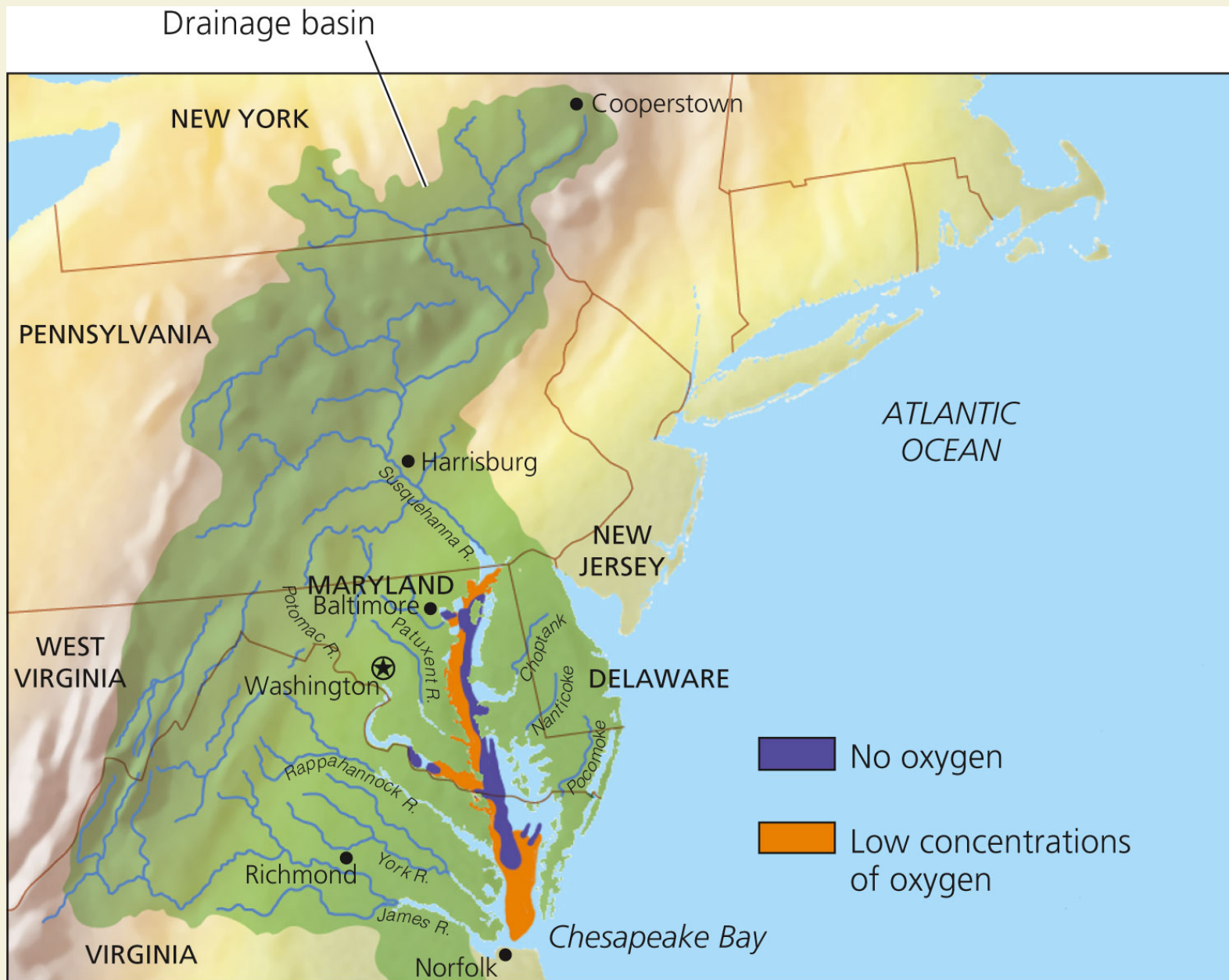
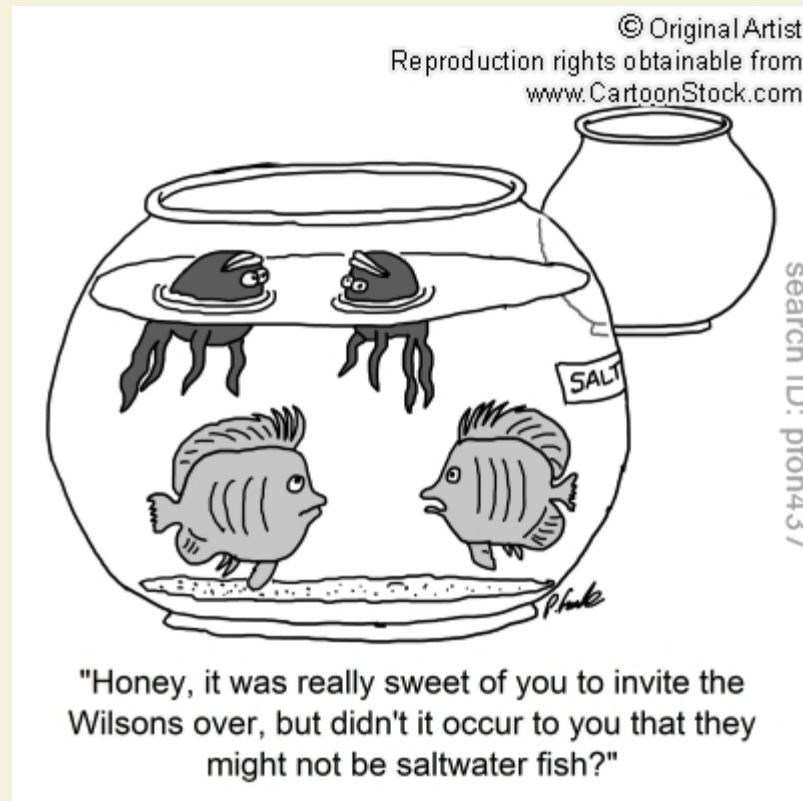


Fig. 8-14, p. 180

8-4 Why Are Freshwater Ecosystems Important?

- **Concept 8-4** *Freshwater ecosystems provide major ecological and economic services, and are irreplaceable reservoirs of biodiversity.*



Water Stands in Some Freshwater Systems and Flows in Others (1)

- Standing (lentic) bodies of freshwater
 - Lakes
 - Ponds
 - Inland wetlands
- Flowing (lotic) systems of freshwater
 - Streams
 - Rivers

Water Stands in Some Freshwater Systems and Flows in Others (2)

- Four zones based on depth and distance from shore
 1. Littoral zone
 - Near shore where rooted plants grow
 - High biodiversity
 - Turtles, frogs, crayfish, some fish
 2. Limnetic zone
 - Open, sunlight area away from shore
 - Main photosynthetic zone
 - Some larger fish

Water Stands in Some Freshwater Systems and Flows in Others (3)

3. Profundal zone

- Deep water too dark for photosynthesis
- Low oxygen levels
- Some fish

4. Benthic zone

- Decomposers
- Detritus feeders
- Some fish
- Nourished primarily by dead matter

Major Ecological and Economic Services Provided by Freshwater Systems

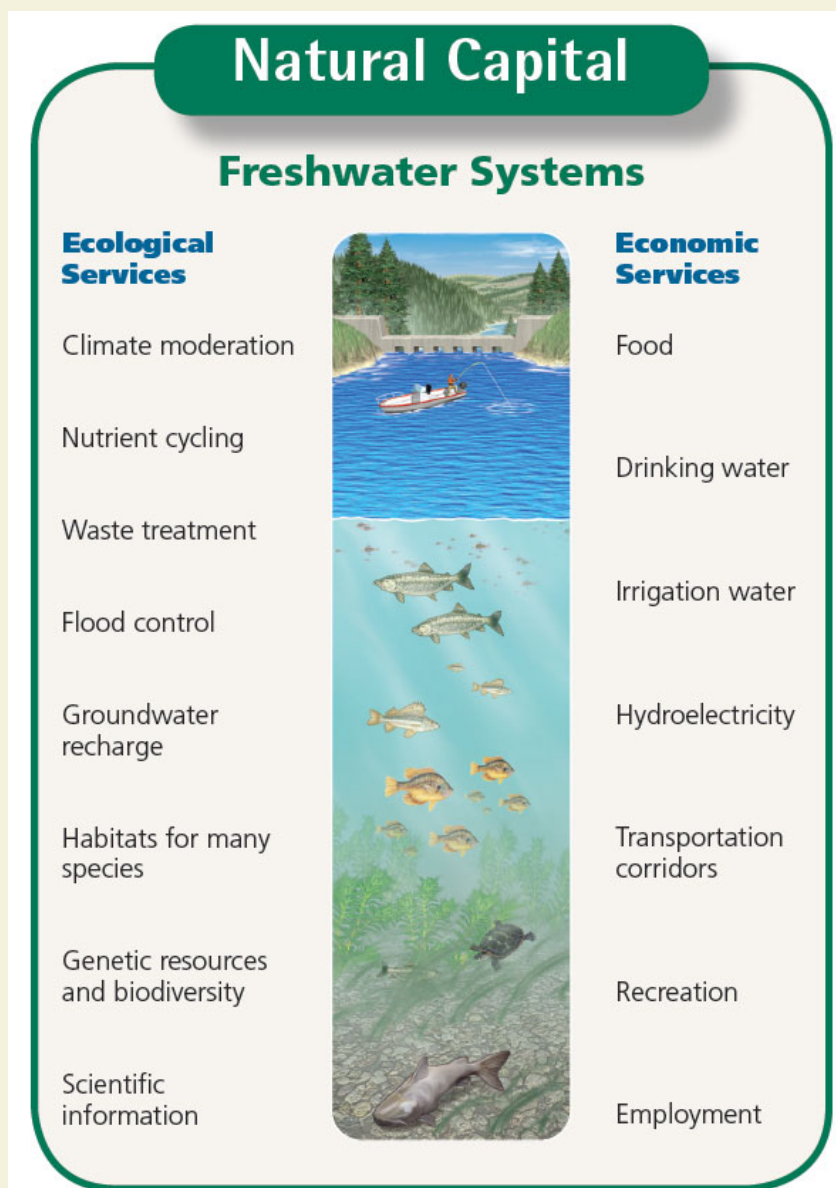


Fig. 8-15, p. 181

Distinct Zones of Life in a Fairly Deep Temperate Zone Lake

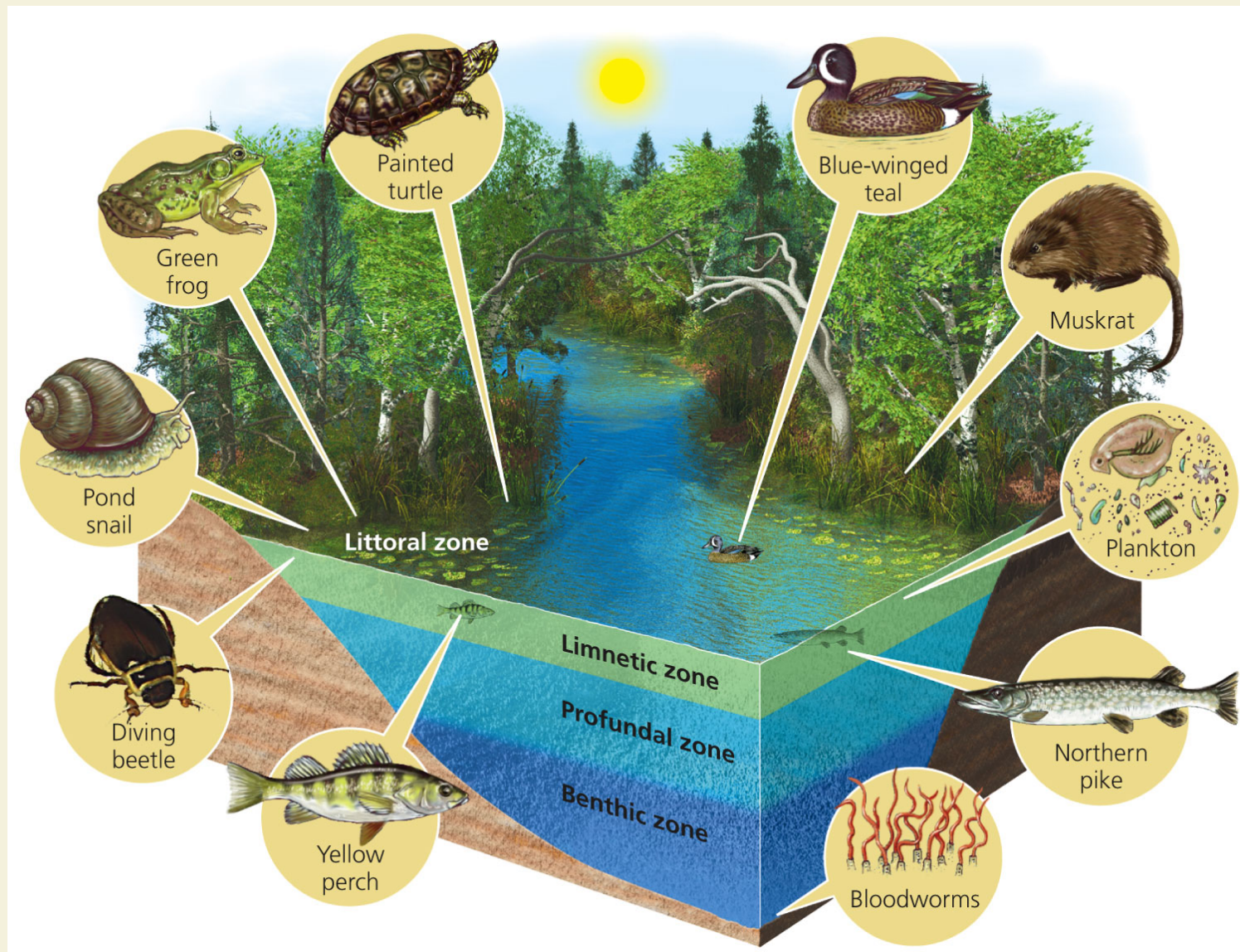


Fig. 8-16, p. 182

Some Lakes Have More Nutrients Than Others

- **Oligotrophic lakes**
 - Low levels of nutrients and low NPP
 - Very clear water
- **Eutrophic lakes**
 - High levels of nutrients and high NPP
 - Murky water with high turbidity
- **Mesotrophic lakes**
- **Cultural eutrophication** of lakes from human input of nutrients

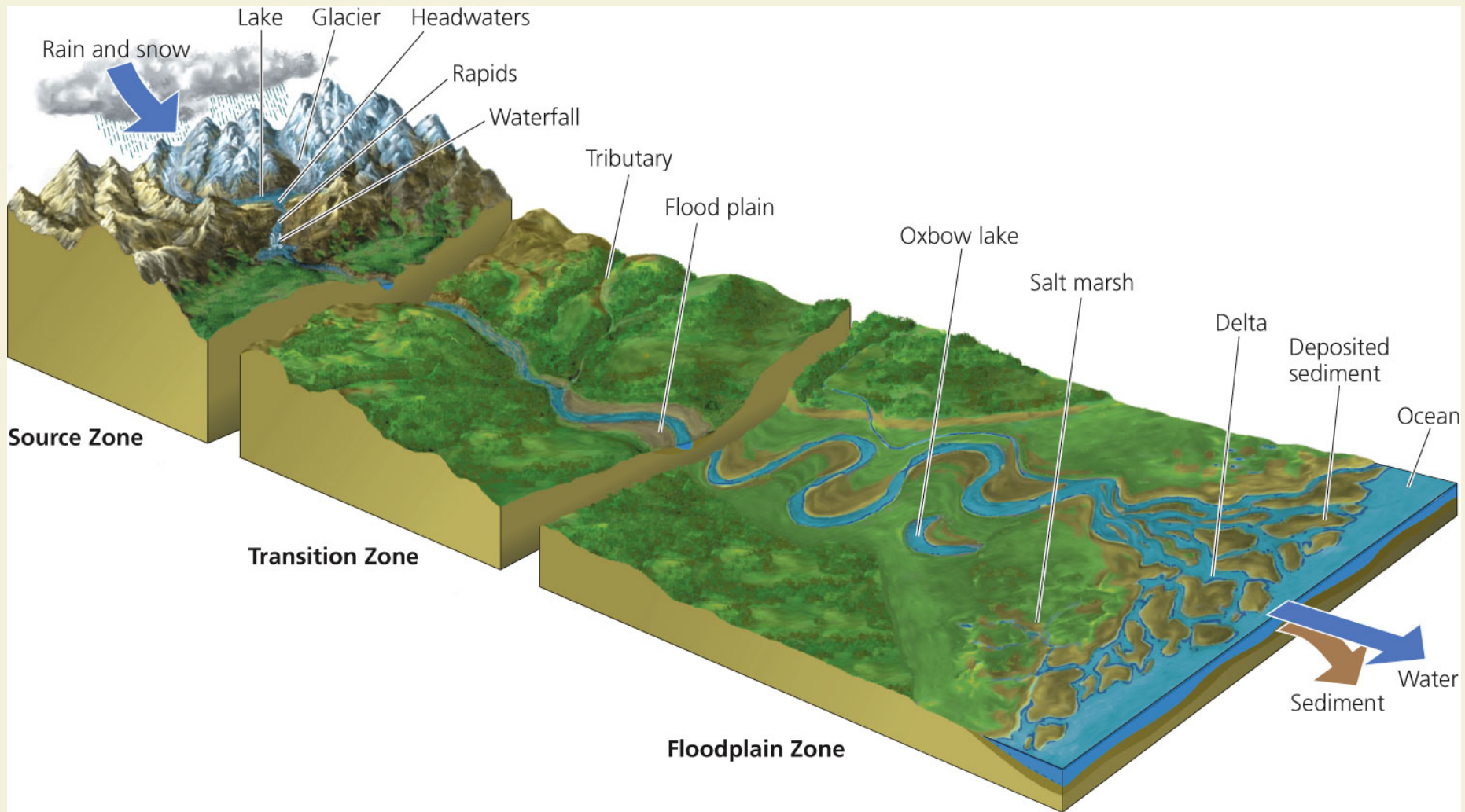
The Effect of Nutrient Enrichment on a Lake



Freshwater Streams and Rivers Carry Water from the Mountains to the Oceans

- **Surface water**
- **Runoff**
- **Watershed, drainage basin**
- Three aquatic life zones
 - Source zone
 - Transition zone
 - Floodplain zone

Three Zones in the Downhill Flow of Water



Case Study: Dams, Deltas, Wetlands, Hurricanes, and New Orleans

- Coastal deltas, mangrove forests, and coastal wetlands: natural protection against storms
- Dams and levees reduce sediments in deltas: significance?
- New Orleans, Louisiana, and Hurricane Katrina: August 29, 2005
- Global warming, sea rise, and New Orleans

New Orleans, Louisiana Flooded by Hurricane Katrina



Fig. 8-19, p. 185



Projection of New Orleans if the Sea Level Rises 0.9 Meter

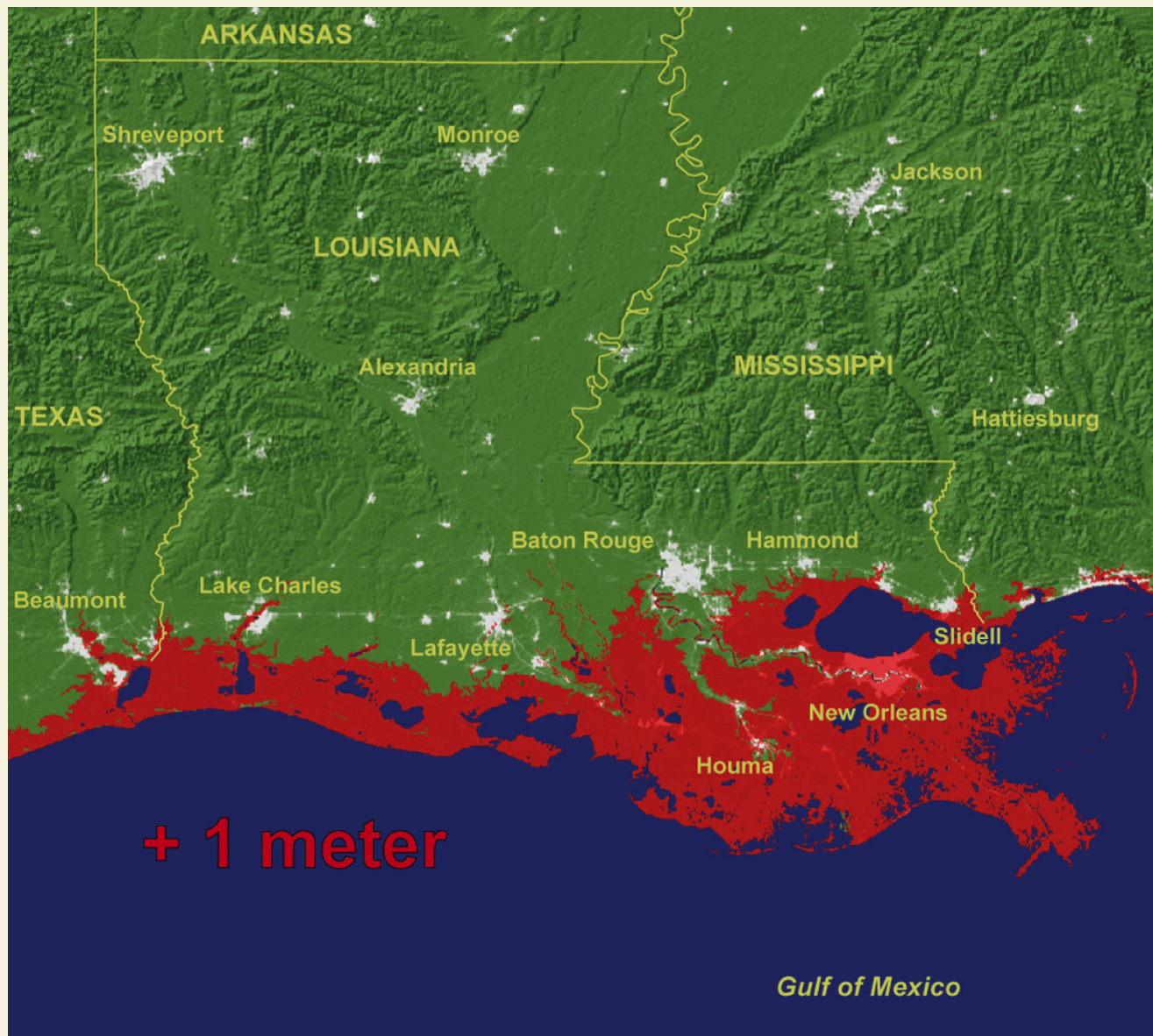


Fig. 8-20, p. 185

Freshwater Inland Wetlands Are Vital Sponges (1)

- Marshes
- Swamps
- Prairie potholes
- Floodplains
- Arctic tundra in summer



Freshwater Inland Wetlands Are Vital Sponges (2)

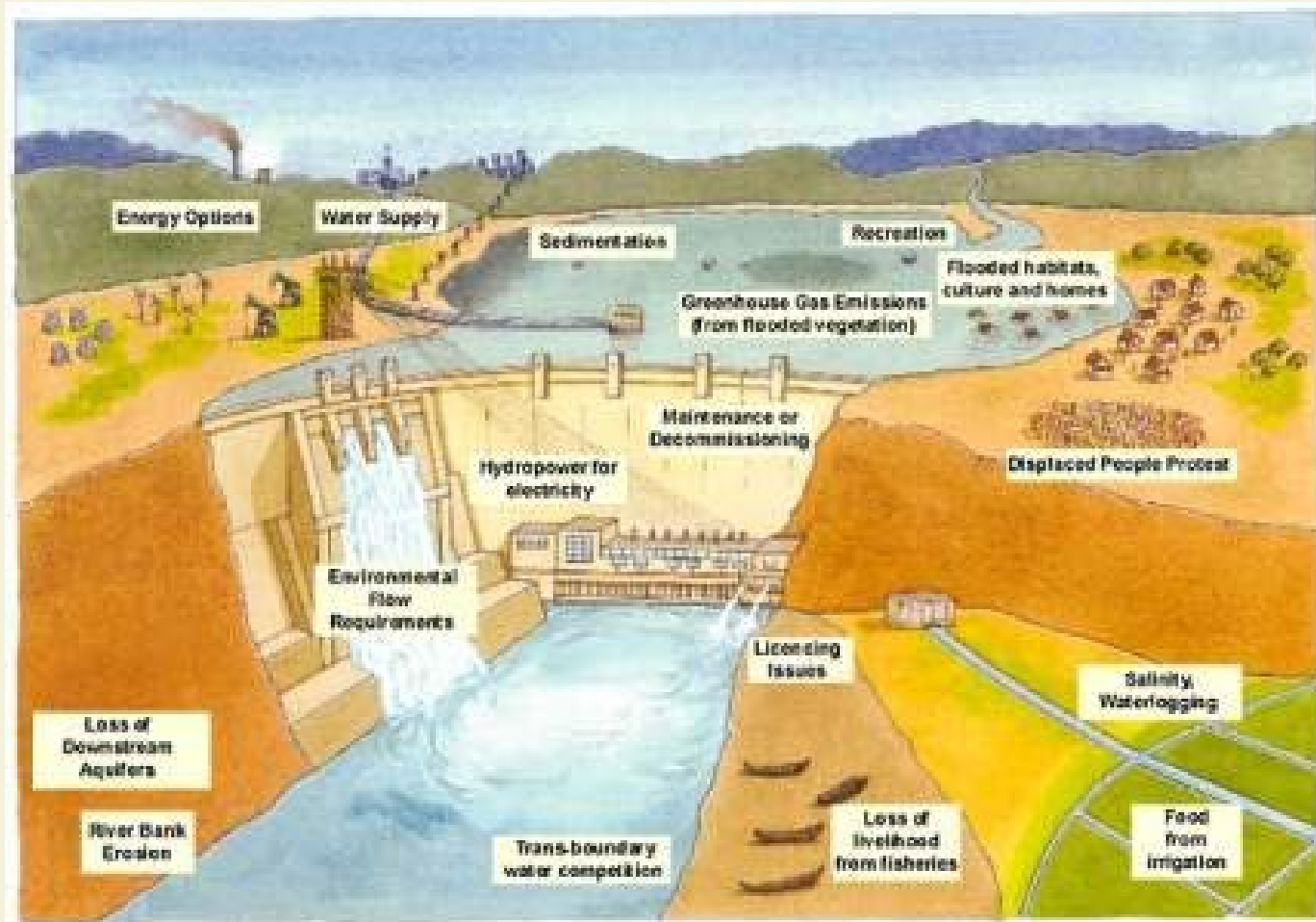
- Provide free ecological and economic services
 - Filter and degrade toxic wastes
 - Reduce flooding and erosion
 - Help to replenish streams and recharge groundwater aquifers
 - Biodiversity
 - Food and timber
 - Recreation areas

8-5 How Have Human Activities Affected Freshwater Ecosystems?

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

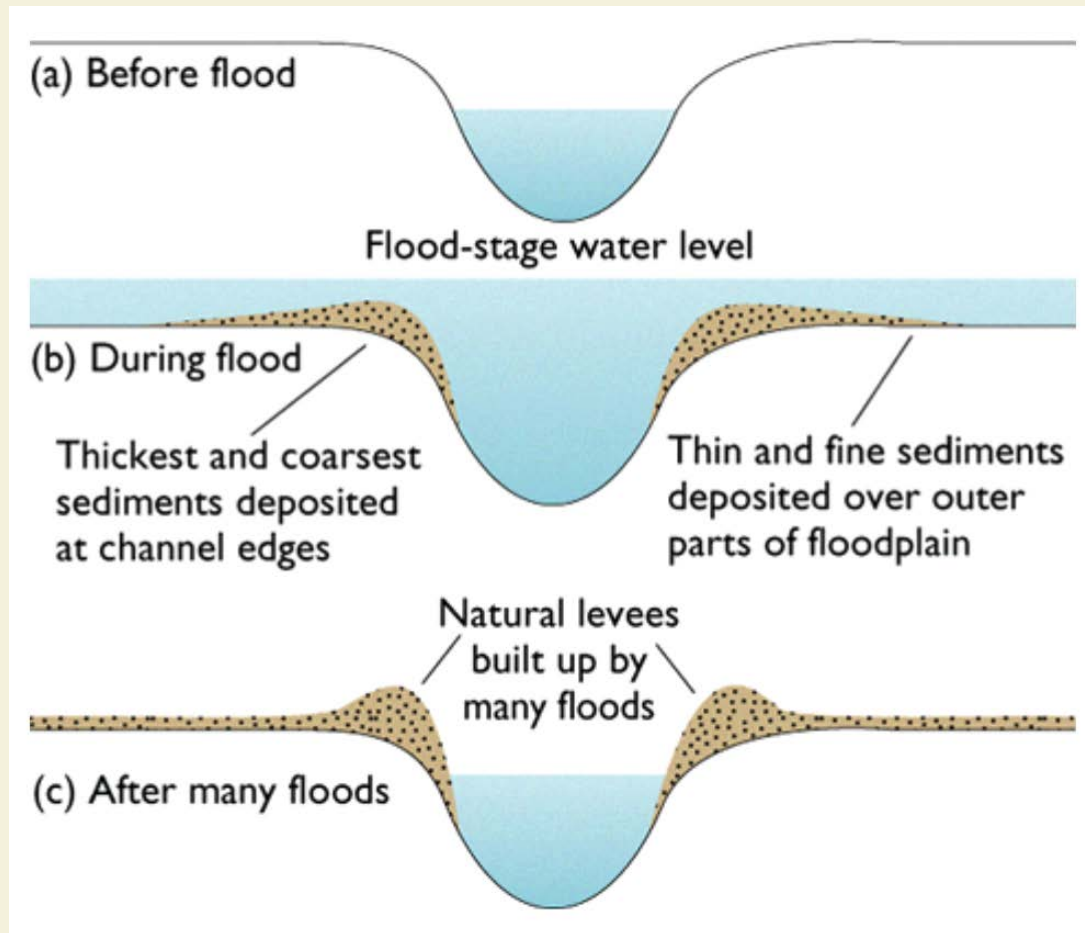
Human Activities Are Disrupting and Degrading Freshwater Systems

- Impact of dams and canals on rivers



Human Activities Are Disrupting and Degrading Freshwater Systems

- Impact of flood control levees and dikes along rivers



Human Activities Are Disrupting and Degrading Freshwater Systems

- Impact of pollutants from cities and farms on streams, rivers, and lakes



Human Activities Are Disrupting and Degrading Freshwater Systems

- Impact of drained wetlands



Three Big Ideas

1. Saltwater and freshwater aquatic life zones cover almost three-fourths of the earth's surface, and oceans dominate the planet.
2. The earth's aquatic systems provide important ecological and economic services.
3. Human activities threaten biodiversity and disrupt ecological and economic services provided by aquatic systems.