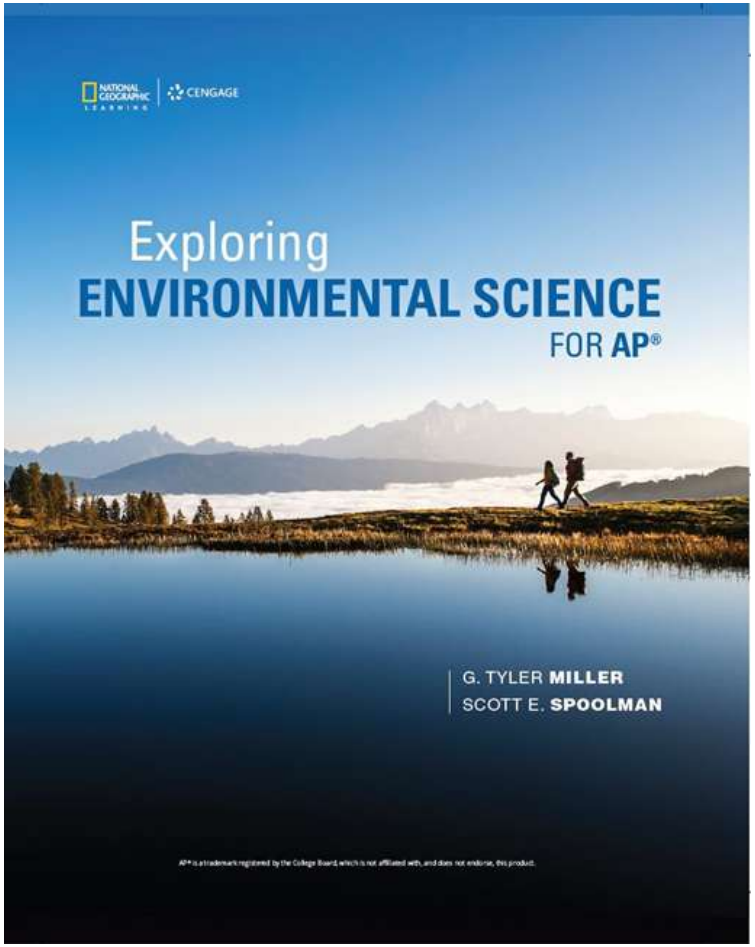
Exploring Environmental Science for AP®

1st Edition



Chapter 6
Aquatic Biodiversity

Core Case Study: Why Should We Care about Coral Reefs? (1 of 3)

- Coral reefs among world's oldest, most diverse, and most productive ecosystems
  - Form in clear, warm coastal waters in tropical areas
  - Tiny animals (polyps) and single-celled algae have a mutualistic relationship
  - Polyps secrete calcium carbonate shells, which become coral reefs

Core Case Study: Why Should We Care about Coral Reefs? (2 of 3)

- Provide important ecological and economic services
  - Natural barrier to protect coastlines
  - Habitat, food, or spawning grounds for one-quarter to one-third of ocean's organisms
- Vulnerable to damage
  - Soil runoff
  - Climate change increasing ocean temperature
  - Increasing ocean acidity

Core Case Study: Why Should We Care about Coral Reefs? (3 of 3)

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6.1 What Is the General Nature of Aquatic Systems?

- Saltwater and freshwater aquatic life zones cover almost three-fourths of the earth's surface
- Factors determining aquatic biodiversity
  - Temperature
  - Dissolved oxygen content
  - Availability of food
  - Access to light and nutrients necessary for photosynthesis

Most of the Earth Is Covered with Water (1 of 2)

- Saltwater covers 71% of earth's surface
  - Freshwater occupies another 2%
- Global ocean divided into five areas
  - Atlantic
  - Pacific
  - Arctic
  - Indian
  - Southern

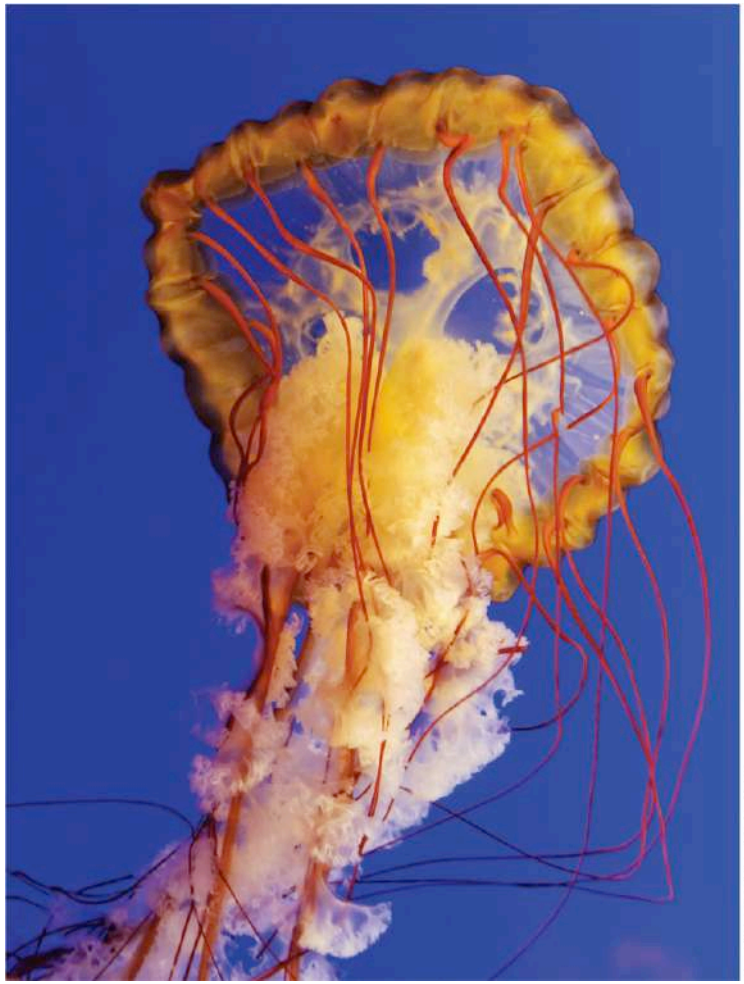
Most of the Earth Is Covered with Water (2 of 2)

- Distribution of organisms determined largely by salinity
- Aquatic life zones
  - Saltwater life zones (marine life zones)
    - Examples: oceans, estuaries, coasts, coral reefs, and mangrove forests
  - Freshwater life zones
    - Examples: lakes, rivers, streams, and inland wetlands

Aquatic Species Drift, Swim, Crawl, and Cling (1 of 4)

- Plankton–drifting
  - Phytoplankton
    - Primary producers for most aquatic food webs
  - Ultraplankton
    - Tiny photosynthetic bacteria
  - Zooplankton
    - Secondary consumers
    - Range from single-celled to large invertebrates like jellyfish

Aquatic Species Drift, Swim, Crawl, and Cling (2 of 4)



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Aquatic Species Drift, Swim, Crawl, and Cling (3 of 4)

- Nekton
  - Strong swimmers–fish, turtles, whales
- Benthos
  - Bottom dwellers–oysters, sea stars, clams, lobsters, crabs
- Decomposers
  - Mostly bacteria

Aquatic Species Drift, Swim, Crawl, and Cling (4 of 4)

- Key factors in the types and numbers of organisms
  - Temperature
  - Dissolved oxygen content
  - Availability of food
  - Availability of light and nutrients needed for photosynthesis
- Turbidity
  - Degree of cloudiness in water

6.2 Why Are Marine Aquatic Systems Important?

- Saltwater ecosystems
  - Provide major ecosystem and economic services
  - Irreplaceable reservoirs of biodiversity

Oceans Provide Vital Ecosystem and Economic Services (1 of 4)

- Oceans produce more than half of oxygen we breathe
  - Provide most of the rain that sustains water supply
- 110 million tons of seafood harvested per year
- The earth's oceans are poorly understood
  - Potential source of ecological and economic benefits

Oceans Provide Vital Ecosystem and Economic Services (2 of 4)

- Three major life zones
  - Coastal zone
    - Warm, nutrient rich, shallow water
    - Extends from land to edge of continental shelf
    - Makes up less than 10% of world's ocean area
    - Contains 90% of all marine species
  - Open sea
  - Ocean bottom

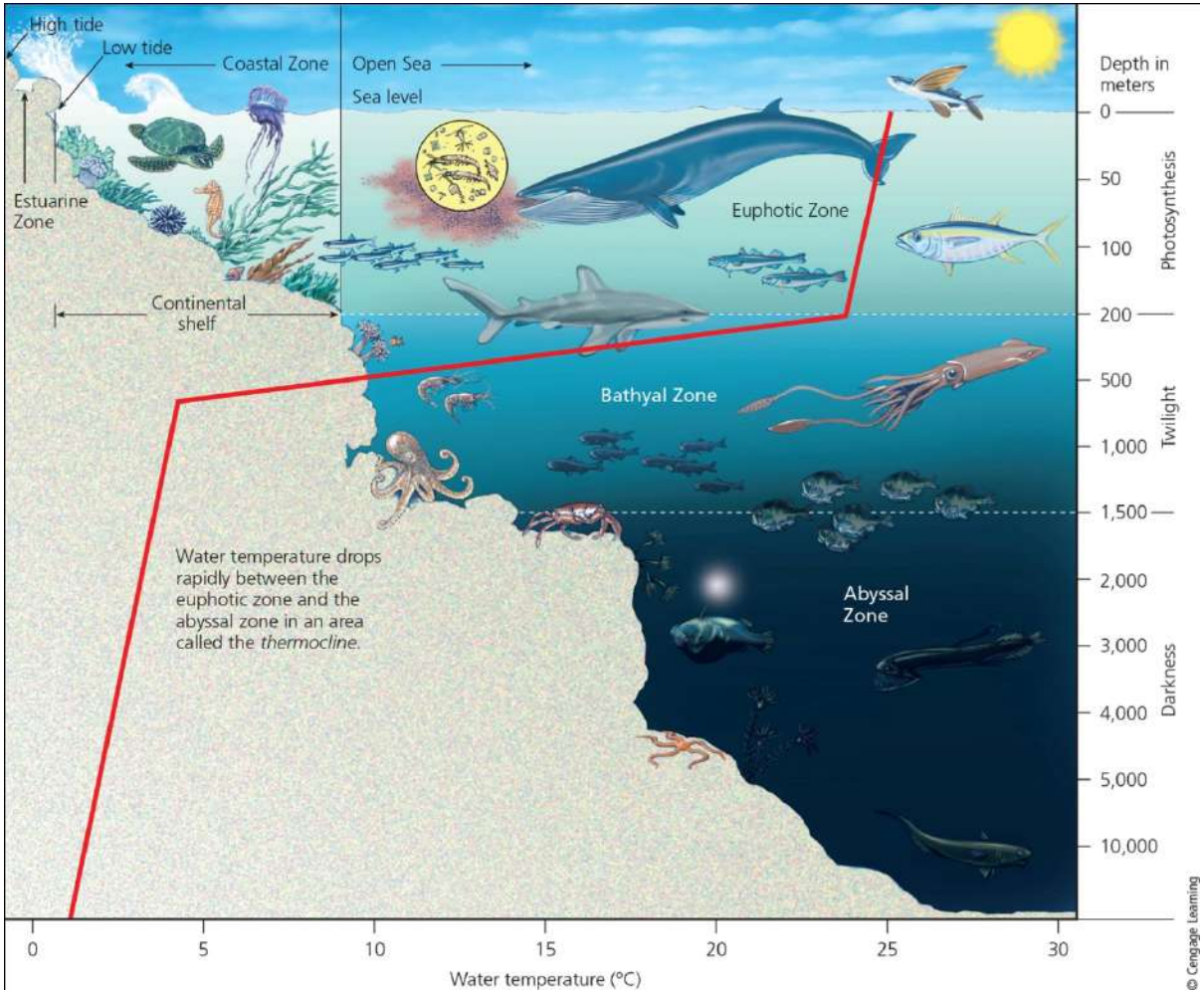
Oceans Provide Vital Ecosystem and Economic Services (3 of 4)

Natural Capital

Marine Ecosystems

Ecosystem Services		Economic Services
Oxygen supplied through photosynthesis		Food
Water purification		Energy from waves and tides
Climate moderation		Pharmaceuticals
CO_2 absorption		Harbors and transportation routes
Nutrient cycling		Recreation and tourism
Reduced storm damage (mangroves, barrier islands, coastal wetlands)		Employment
Biodiversity: species and habitats		Minerals

Oceans Provide Vital Ecosystem and Economic Services (4 of 4)



Estuaries and Coastal Wetlands Are Highly Productive (1 of 6)

- Estuaries
  - Aquatic zone where river meets the sea
- Coastal wetlands
  - Coastal land covered with water all or part of the year
  - Include coastal marshes (salt marshes) and mangrove forests
- Very productive ecosystems with high nutrient levels

Estuaries and Coastal Wetlands Are Highly Productive (2 of 6)

- Seagrass beds
  - Occur in shallow coastal water
  - Host up to 60 species of grasses and plants
  - Support a variety of marine species

Estuaries and Coastal Wetlands Are Highly Productive (3 of 6)

Estuaries and Coastal Wetlands Are Highly Productive (4 of 6)

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Estuaries and Coastal Wetlands Are Highly Productive (5 of 6)

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Estuaries and Coastal Wetlands Are Highly Productive (6 of 6)

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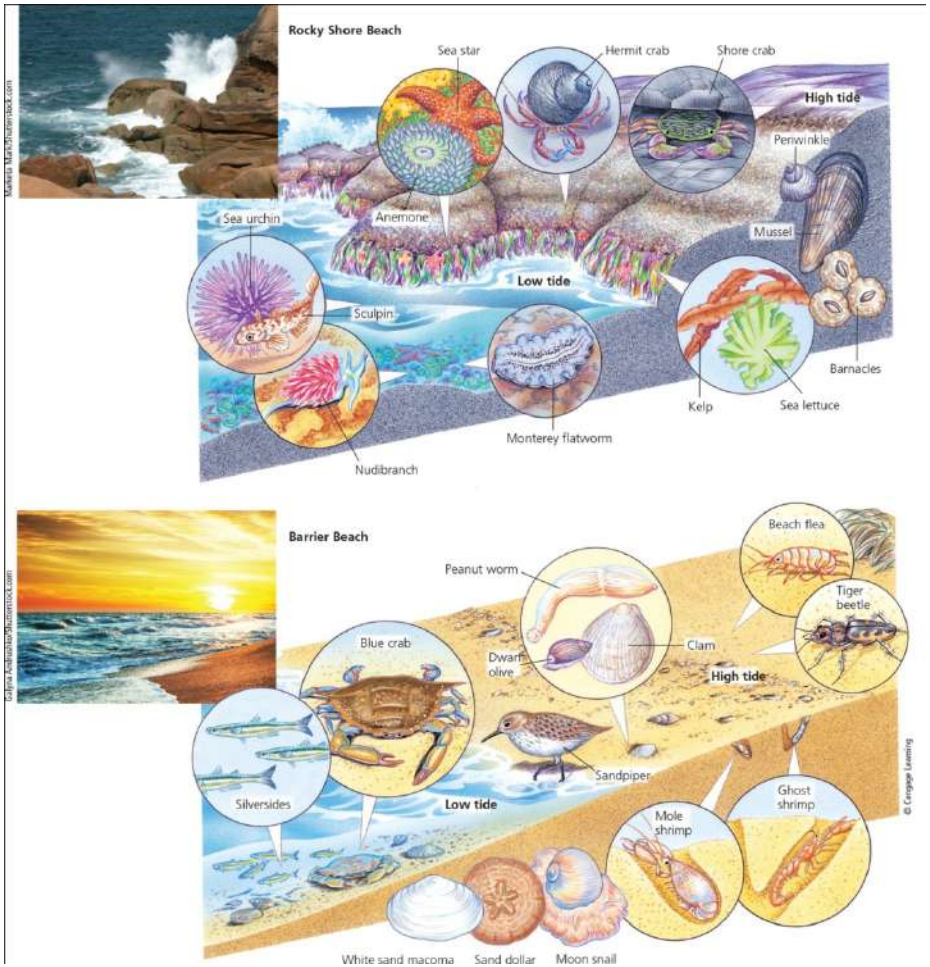
Rocky and Sandy Shores Host Different Types of Organisms (1 of 2)

- Intertidal zone
  - Area of shore between high and low tides
- Organisms must survive with daily salinity and moisture changes
- Rocky shores
  - Pounded by waves
- Barrier beaches (sandy shores)
  - Most organisms burrow, dig, or tunnel in sand

Rocky and Sandy Shores Host Different Types of Organisms (2 of 2)



Critical Concept: The Importance of Wetlands (1 of 2)

- Wetlands are areas that are saturated with water all or part of the year
  - Have standing shallow water with emergent vegetation
  - Contain communities of plants and animals that have adapted to continuously wet conditions
- Freshwater wetlands include
  - Swamps
  - Marshes
  - Bogs
  - Fens
  - Prairie potholes

Critical Concept: The Importance of Wetlands (2 of 2)

- Saltwater wetlands include
  - Estuaries
  - Mangrove swamps
  - Coastal marshes
- Both provide many ecosystems services

Case Study: Revisiting Coral Reefs -Amazing Centers of Biodiversity

- Marine equivalent of tropical rain forests
- Reefs are being destroyed and damaged worldwide
- Ocean acidification
  - Oceans absorb CO_2
  - CO_2 reacts with ocean water to form a weak acid that decreases levels of carbonate ions (CO_3^{2-}) needed to form coral

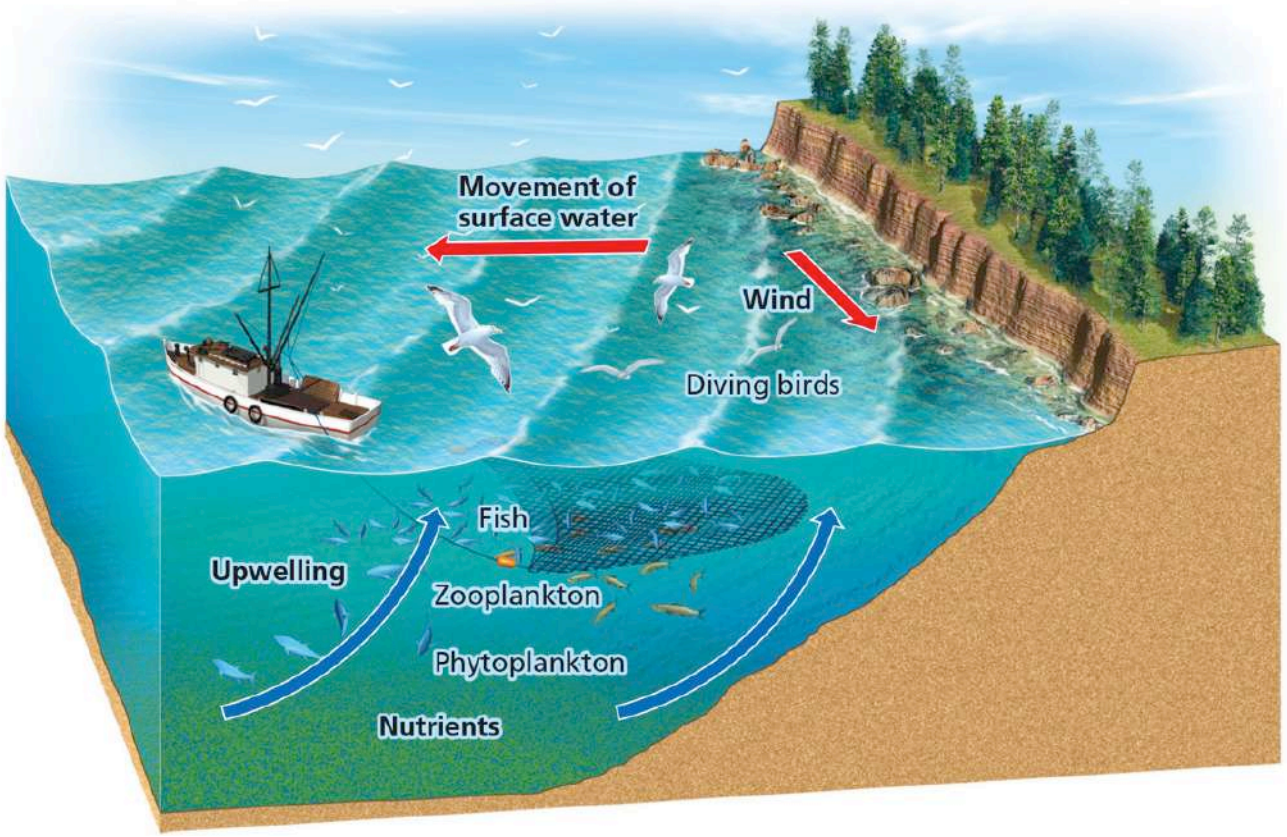
The Open Sea and the Ocean Floor Host a Variety of Species (1 of 3)

- Three vertical zones of the open sea (pelagic zone)
  - Euphotic zone
    - Phytoplankton
    - Nutrient levels low
    - Dissolved oxygen levels high
    - Upwelling brings nutrients from below
  - Bathyal zone
    - Dimly lit middle zone
    - Zooplankton and smaller fishes

The Open Sea and the Ocean Floor Host a Variety of Species (2 of 3)

- Three vertical zones (cont'd.)
  - Abyssal zone
    - Dark and cold
    - High levels of nutrients
    - Little dissolved oxygen
    - Deposit feeders
    - Filter feeders
- NPP low in the open sea
  - Except in upwelling areas

The Open Sea and the Ocean Floor Host a Variety of Species (3 of 3)



Science Focus 6.1: We Are Still Learning about the Ocean's Biodiversity

- Scientists took census of ocean microbes
  - Process took 2 years
  - Sailed around the world, sampling seawater
  - Counted genetic coding for six million previously undiscovered proteins
  - Still discovering new genes and proteins at end of voyage
- Ocean contains higher diversity of microbial life than previously thought

6.3 How Have Human Activities Affected Marine Ecosystems?

- Human activities threaten aquatic biodiversity
  - Disrupt ecosystem and economic services provided by saltwater systems
- Climate change and ocean acidification are largest threats

Human Activities Are Disrupting and Degrading Marine Systems (1 of 2)

- Other threats from human activities
  - Coastal development
    - Destroys or degrades coastal habitats
  - Overfishing
  - Destruction of ocean bottom habitats
  - Runoff of pollutants
  - Pollution from ships and tanker spills
  - Introduction of invasive species

Human Activities Are Disrupting and Degrading Marine Systems (2 of 2)

6.4 Why Are Freshwater Ecosystems Important?

- Freshwater ecosystems
  - Provide major ecosystem and economic services
  - Irreplaceable reservoirs of biodiversity

Water Stands in Some Freshwater Systems and Flows in Others (1 of 5)

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

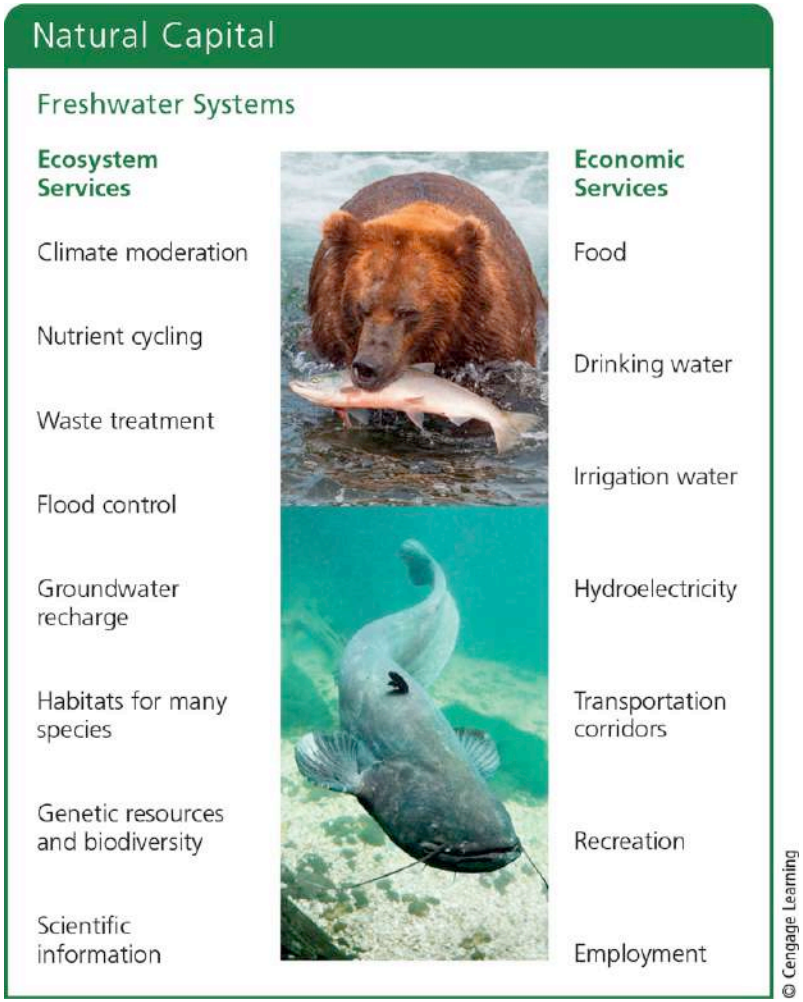
Water Stands in Some Freshwater Systems and Flows in Others (2 of 5)

- Lakes have four life zones defined by depth and distance from shore
  - Littoral zone
    - Shallow water near shore where rooted plants grow; high biodiversity
    - Turtles, frogs, crayfish, some fish
  - Limnetic zone
    - Open, sunlight area away from shore; main photosynthetic zone
    - Some larger fish

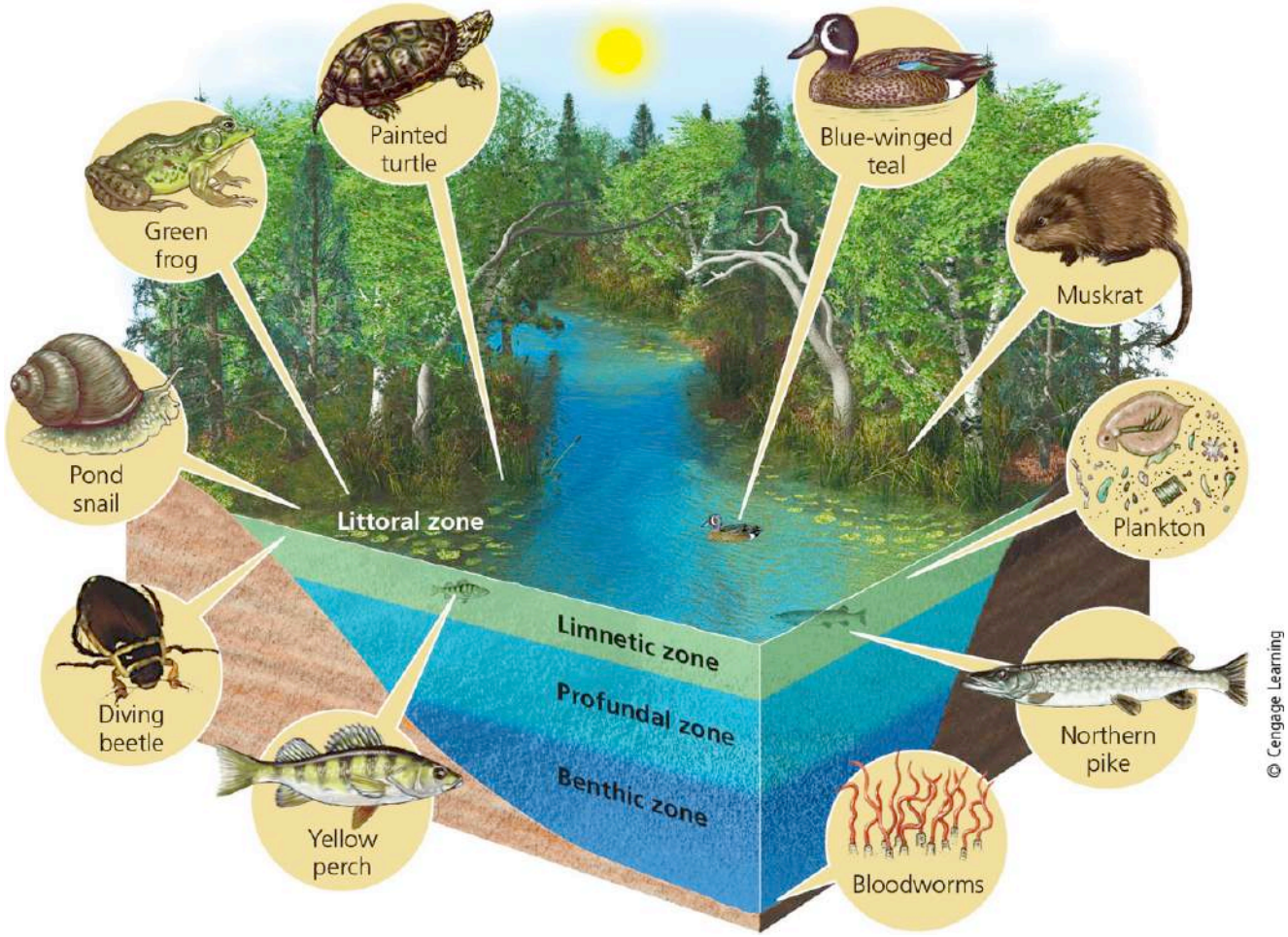
Water Stands in Some Freshwater Systems and Flows in Others (3 of 5)

- Lake zones (cont'd.)
  - Profundal zone
    - Deep water too dark for photosynthesis
    - Low oxygen levels
    - Some fish
  - Benthic zone
    - Lake bottom
    - Decomposers, detritus feeders, and some fish
    - Nourished primarily by dead matter

Water Stands in Some Freshwater Systems and Flows in Others (4 of 5)



Water Stands in Some Freshwater Systems and Flows in Others (5 of 5)



Some Lakes Have More Nutrients Than Others (1 of 3)

- Oligotrophic lakes
  - Low levels of nutrients and low NPP
  - Very clear water
- Eutrophic lakes
  - High levels of nutrients and high NPP
  - Shallow, murky water
- Cultural eutrophication of lakes from human input of nutrients

Some Lakes Have More Nutrients Than Others (2 of 3)

Some Lakes Have More Nutrients Than Others (3 of 3)

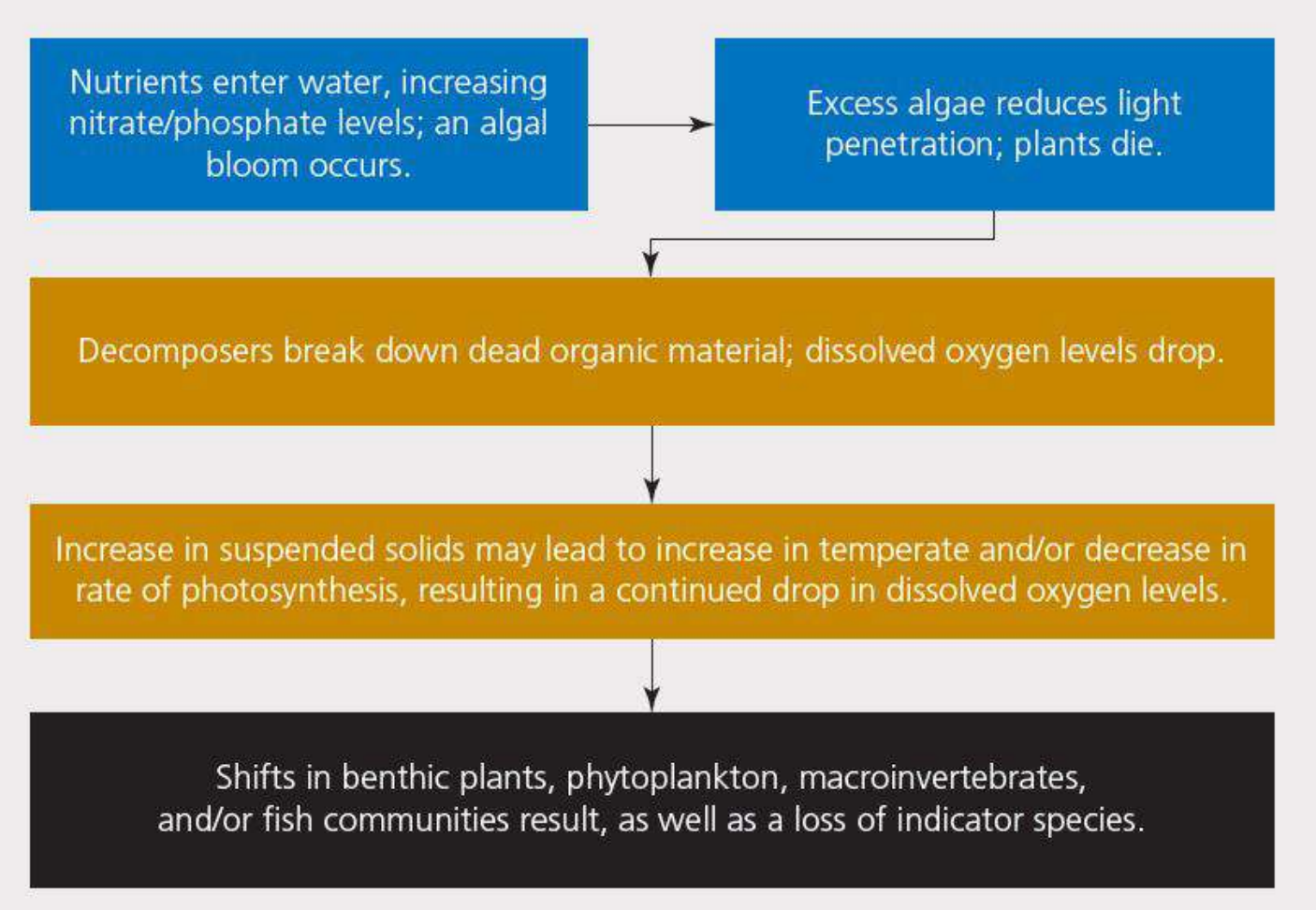
Critical Concept: Cultural Eutrophication (1 of 3)

- The physical, chemical, and biological changes that take place when a freshwater system receives an influx of nutrients
- Limiting factors for plants (nitrates and phosphates) are taken up quickly and cause an algal bloom

Critical Concept: Cultural Eutrophication (2 of 3)

- Sources of nutrients include
  - Fertilizers from lawns and farms
  - Phosphates in detergents
  - Feedlot runoff
  - Municipal sewage
  - Runoff from streets
  - Mining and construction
  - Nitrogen oxides from air pollution

Critical Concept: Cultural Eutrophication (3 of 3)



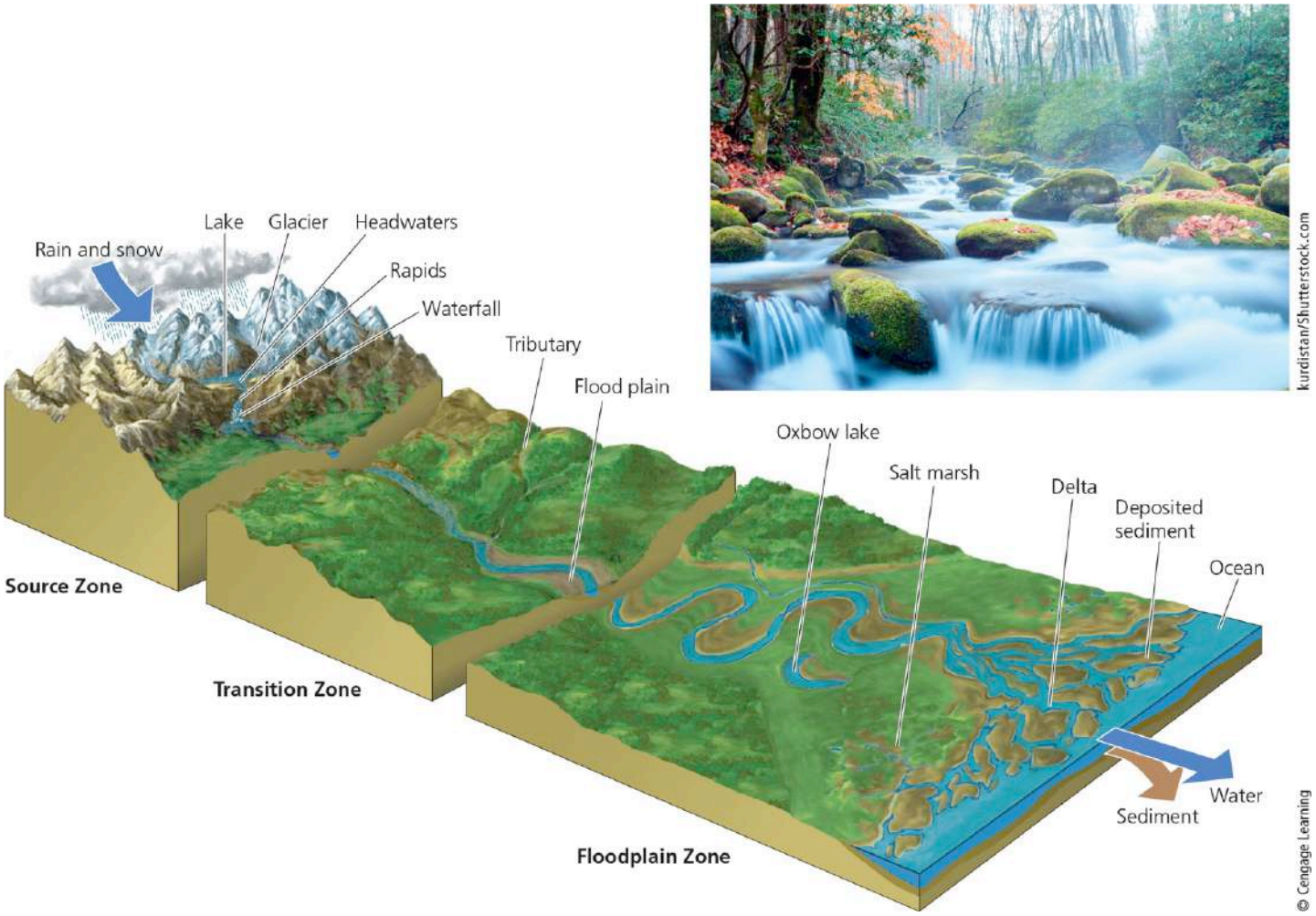
Freshwater Streams and Rivers Carry Large Volumes of Water (1 of 3)

- Downward flow of surface water and groundwater from mountain highlands
- Three aquatic life zones
  - Source zone
    - Shallow, cold, clear, swiftly flowing streams
    - High dissolved oxygen
    - Nutrients come from organic matter

Freshwater Streams and Rivers Carry Large Volumes of Water (2 of 3)

- Aquatic life zones (cont'd.)
  - Transition zone
    - Wider, deeper, warmer streams
    - More turbid, with less dissolved oxygen
  - Floodplain zone
    - Wide, deep rivers that flow across broad, flat valleys
    - Higher temperatures and less dissolved oxygen
    - Support algae, cyanobacteria, rooted plants

Freshwater Streams and Rivers Carry Large Volumes of Water (3 of 3)



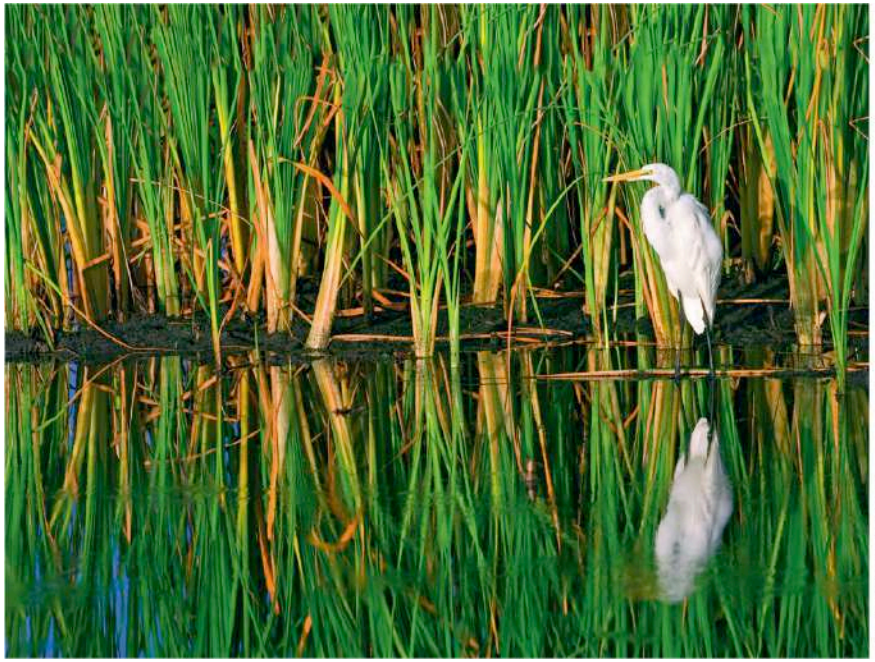
Freshwater Inland Wetlands Are Vital Sponges (1 of 3)

- Inland wetlands
  - Marshes, swamps, prairie potholes, floodplains, and arctic tundra
  - Some are seasonal wetlands
  - Highly productive because of available nutrients
- Services provided
  - Filtering toxic wastes and pollutants
  - Reducing flooding and erosion

Freshwater Inland Wetlands Are Vital Sponges (2 of 3)

- Services provided (cont'd.)
  - Sustaining stream flows during dry periods
  - Recharging groundwater aquifers
  - Providing habitats for a variety of species
  - Supplying valuable products
    - Fishes, shellfish, blueberries, cranberries, and rice
  - Providing recreation

Freshwater Inland Wetlands Are Vital Sponges (3 of 3)



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6.5 How Have Human Activities Affected Freshwater Ecosystems?

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

Human Activities Are Disrupting and Degrading Freshwater Systems

- Dams and canals restrict the flows of rivers
  - 40% of the world's largest rivers
- Flood-control destroys aquatic habitats and alters wetlands
- Cities and farms pollute water
- Many wetlands have been drained for human purposes

River Deltas and Coastal Wetlands–Vital Components of Natural Capital Now In Jeopardy

- River deltas, coastal wetlands, and mangrove forests
  - Provide natural protection against flood and wave damage during storms
    - Degraded ecosystems allow intensified damage
- Building dams reduces river sediment deposited downstream
  - Result: river deltas subside (sink) into the sea

Key Ideas (1 of 2)

- Saltwater and freshwater aquatic life zones cover almost three-fourths of the earth's surface
  - Oceans dominate the planet
- The earth's aquatic systems provide important ecosystem and economic services

Key Ideas (2 of 2)

- Certain human activities threaten biodiversity and disrupt ecosystem and economic services provided by aquatic systems