

Aquatic Biodiversity – Chapter 8

PART 1: OVERVIEW (8.1)

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.*
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The Ocean Planet



Ocean hemisphere



Land-ocean hemisphere

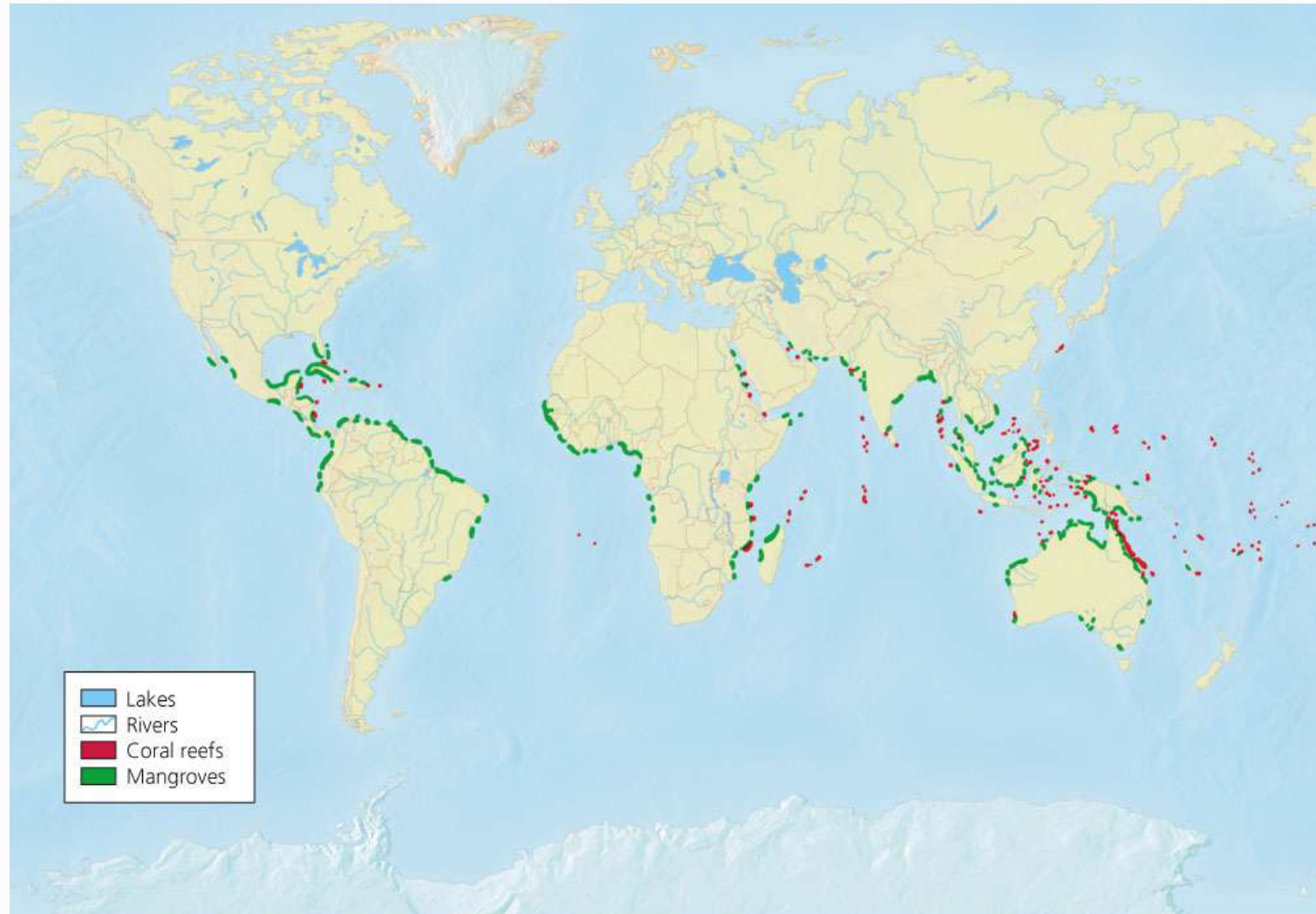
Most of the Earth Is Covered with Water (1)

- Saltwater (71% earth's surface)
 - Global ocean divided into 4 areas
 - Atlantic
 - Pacific*
 - Arctic
 - Indian
 - Freshwater (2.2% earth's surface)
-

Most of the Earth Is Covered with Water (2)

- Aquatic life zones
 - Saltwater/Marine
 - Oceans and estuaries
 - Coastlands and shorelines
 - Coral reefs
 - Mangrove forests
 - Freshwater
 - Lakes
 - Rivers and streams
 - Inland wetlands
-

Distribution of the World's Major Saltwater and Freshwater Sources



Benefits of Oceans

- Biological productivity
 - Climate regulation
 - Role in biogeochemical cycles
 - Biodiversity
 - Goods & Services
 - Fish
 - Shellfish
 - Minerals
 - Recreation
 - Transportation Routes
-

Most Aquatic Species Live in Top, Middle, or Bottom Layers of Water (1)

- **Plankton (weakly swimming/free floating)**
 - Phytoplankton
 - Zooplankton
 - Single celled to jellyfish
 - Ultraplankton
 - Photosynthetic bacteria – 70% of oceans NPP
 - **Nekton**
 - Strongly swimming consumers
 - **Benthos**
 - Bottom dwellers
 - **Decomposers**
-

Most Aquatic Species Live in Top, Middle, or Bottom Layers of Water (2)

- 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
 - Nutrients
 - Plentiful in streams, lake edges & coastlines
 - Nitrates & Phosphates are limiting factors in open ocean
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PART 2: FRESHWATER (8.4)

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
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Major Ecological and Economic Services Provided by Freshwater Systems

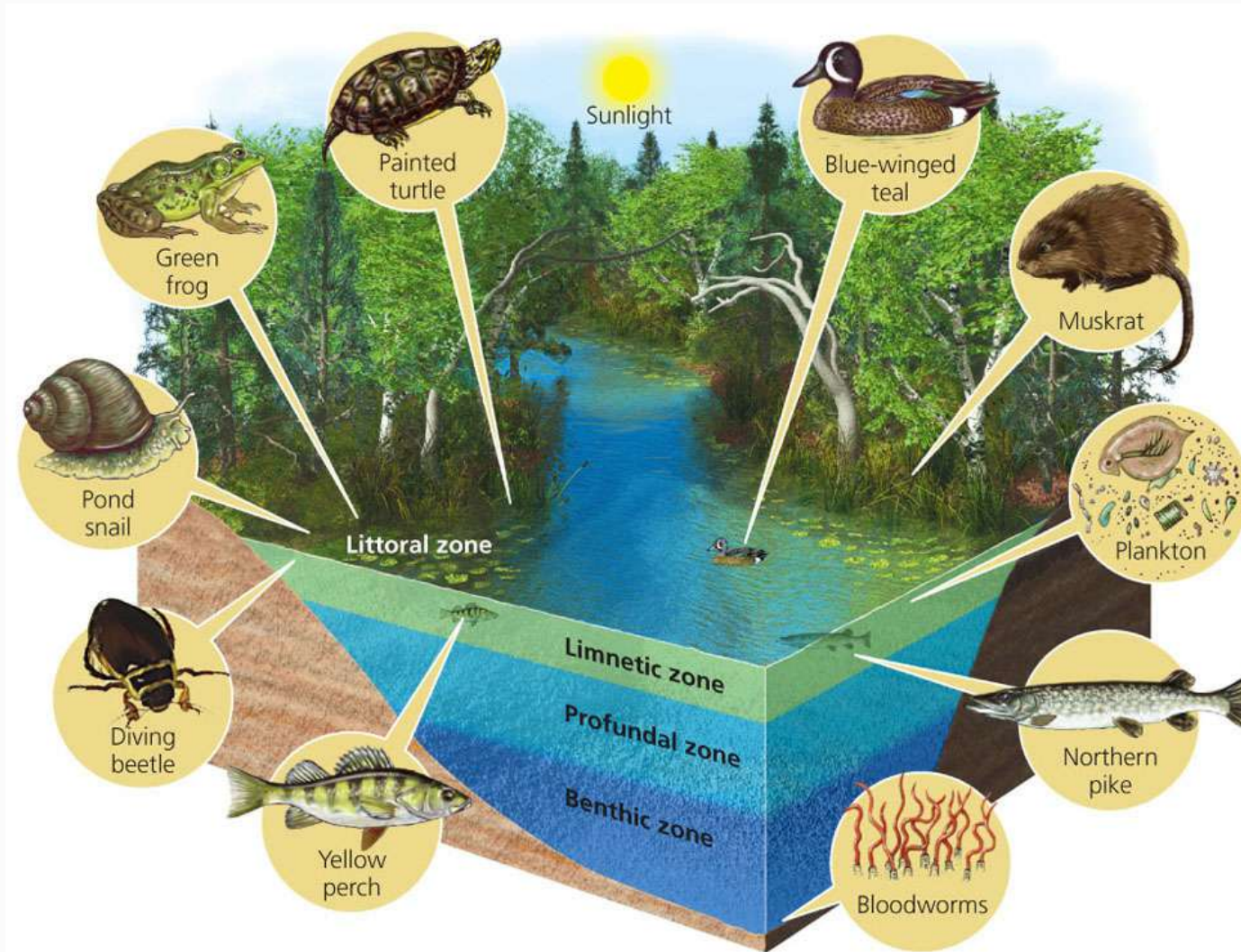


Water Stands in Some Freshwater Systems and Flows in Others (2)

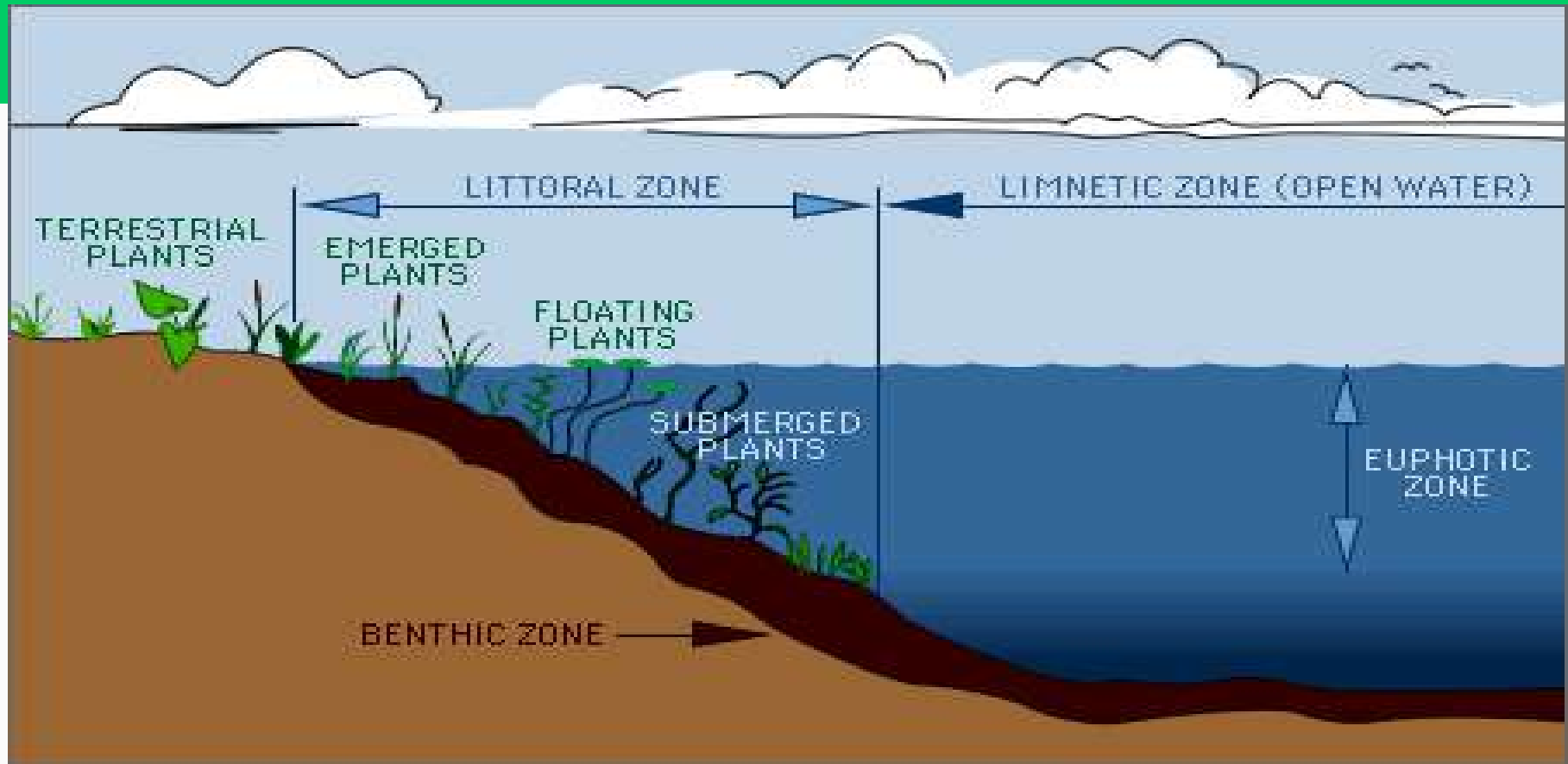
- Formation of lakes
 - Glaciations
 - Crustal displacement
 - Volcanic activity

 - Four zones based on depth and distance from shore
 - **Littoral zone**
 - **Limnetic zone**
 - **Profundal zone**
 - **Benthic zone**
-

Distinct Zones of Life in a Fairly Deep Temperate Zone Lake



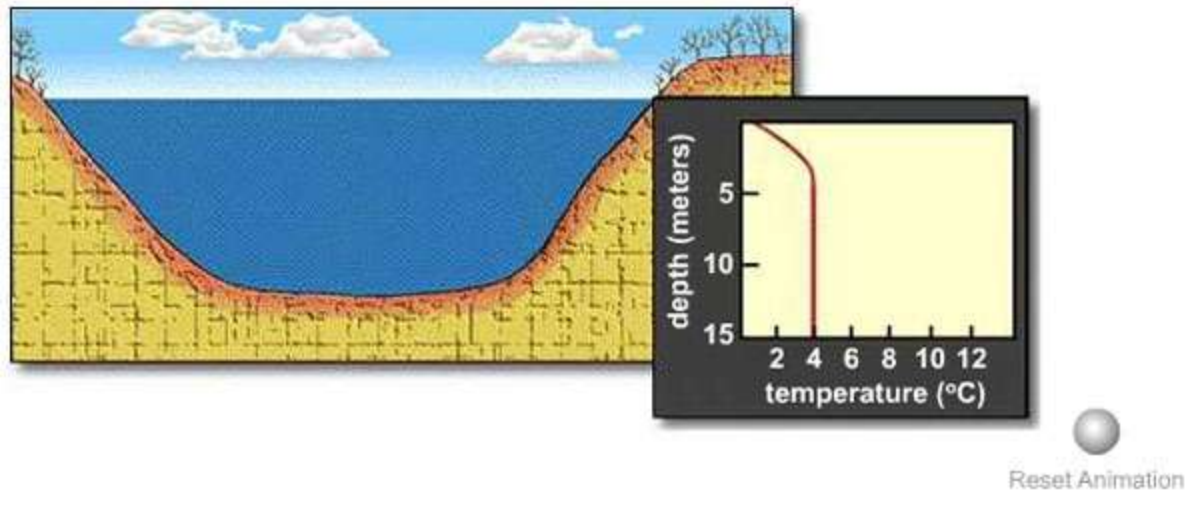
Lake zonation



-The **littoral** zone is the near shore area where sunlight penetrates all the way to the sediment and allows aquatic plants to grow. The **euphotic zone** is the layer from the surface down to the depth where light levels become too low for **photosynthesizers**. In most lakes, the sunlit euphotic zone occurs within the **epilimnion**.

Animation: Lake turnover

process of a **lake's** water turning over from top (epilimnion) to bottom (hypolimnion).



<http://faculty.gvsu.edu/videticp/stratification.htm>

Some Lakes Have More Nutrients Than Others

- **Oligotrophic lakes**
 - Low levels of nutrients and low NPP
 - **Eutrophic lakes**
 - High levels of nutrients and high NPP
 - **Mesotrophic lakes**
 - Cultural eutrophication leads to **hypereutrophic** lakes
-

The Effect of Nutrient Enrichment on a Lake

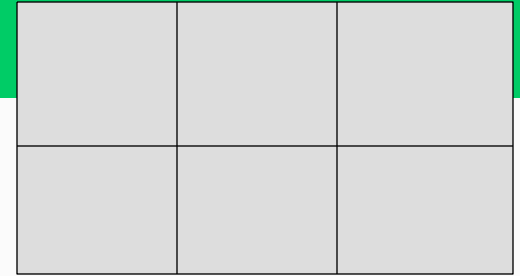


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Cultural Eutrophication

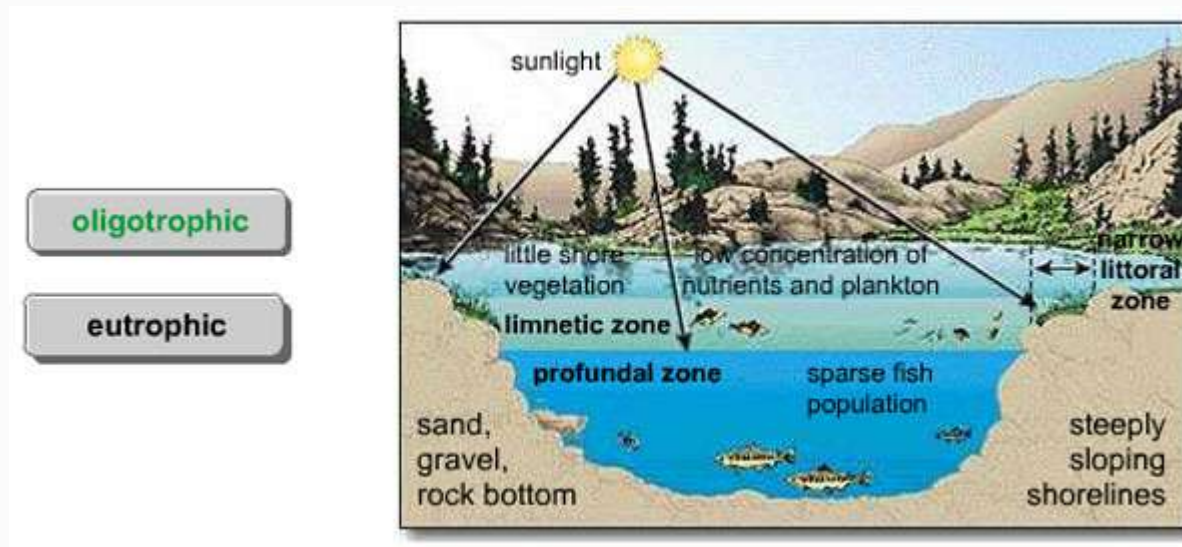


- Homework Instructions
 - Fold your paper into 6 equal sections.
 - You will create a storyboard/cartoon depicting the steps that lead to cultural eutrophication (hypereutrophication)
 - You will first decide on the correct sequence of events.
 - Next, you will write these events in your sections (left to right, top row... then bottom)
 - Finally, you should draw (**very simple**) pictures to represent each stage.

Cultural Eutrophication – Put these in order

- _____ Aerobic bacteria (decomposers) break down dead organisms.
 - _____ Uninhibited plant and algae growth.
 - _____ Fish die.
 - _____ Excessive nutrients are added to the system.
 - _____ Oxygen levels fall.
 - _____ Producers run out of nutrients and die.
-

Animation: Trophic natures of lakes

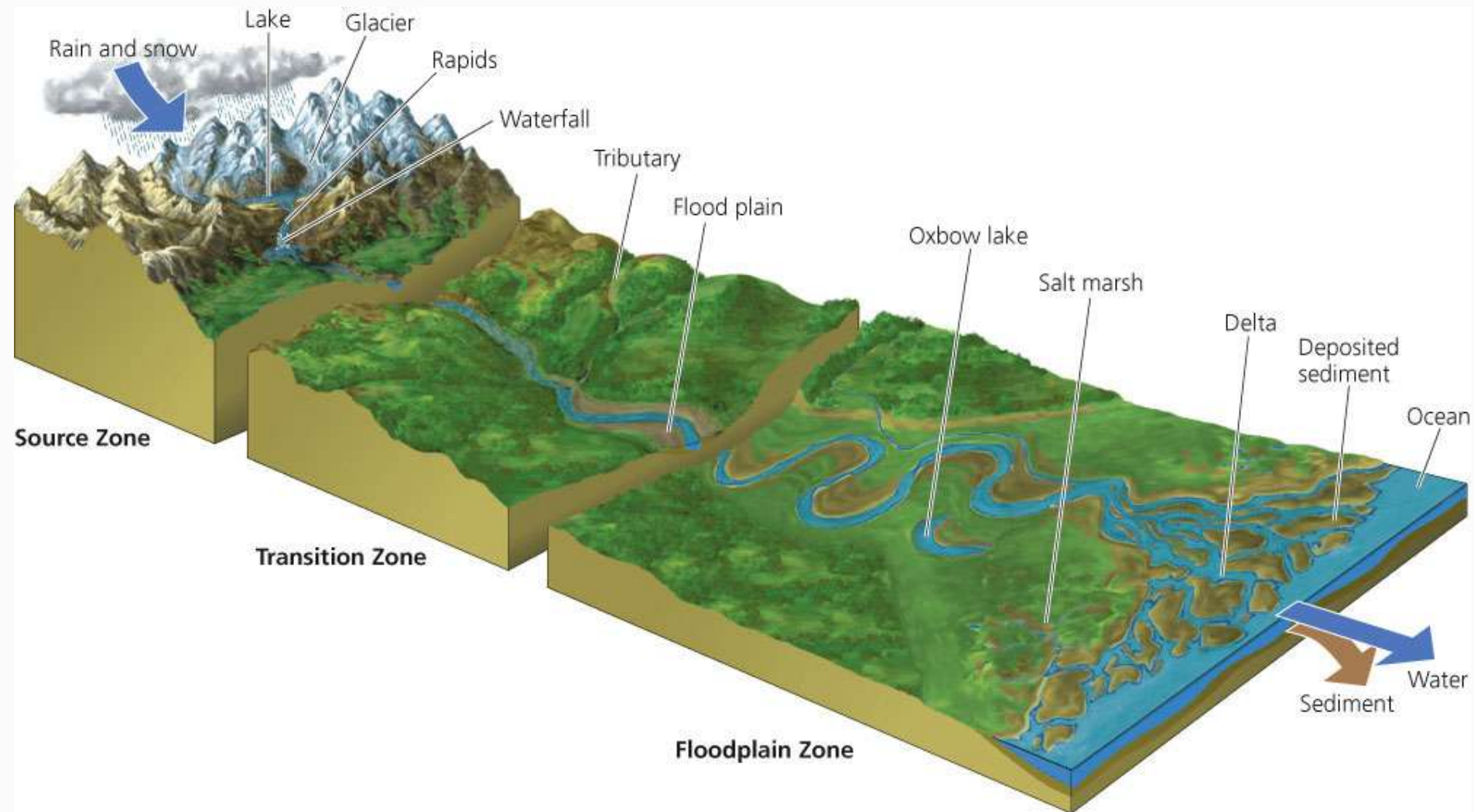


http://rhsweb.org/jstewart/assignments/wwwAPES/Semester1/Ch7/Animations/trophic_lakes.html

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PART 2B: FLOWRING FRESHWATER (8.4)

Three Zones in the Downhill Flow of Water



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

- Three aquatic life zones
 - **Source zone**
 - Shallow, cold, clear, swift
 - High DO
 - Low nutrients & producers
 - **Transition zone**
 - Wider, deeper, warmer, slower
 - More turbid (sediment)
 - Lower DO
 - **Floodplain zone**
 - Wide, deep, warm, very slow
 - Low DO
 - Silt, sediment
-

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

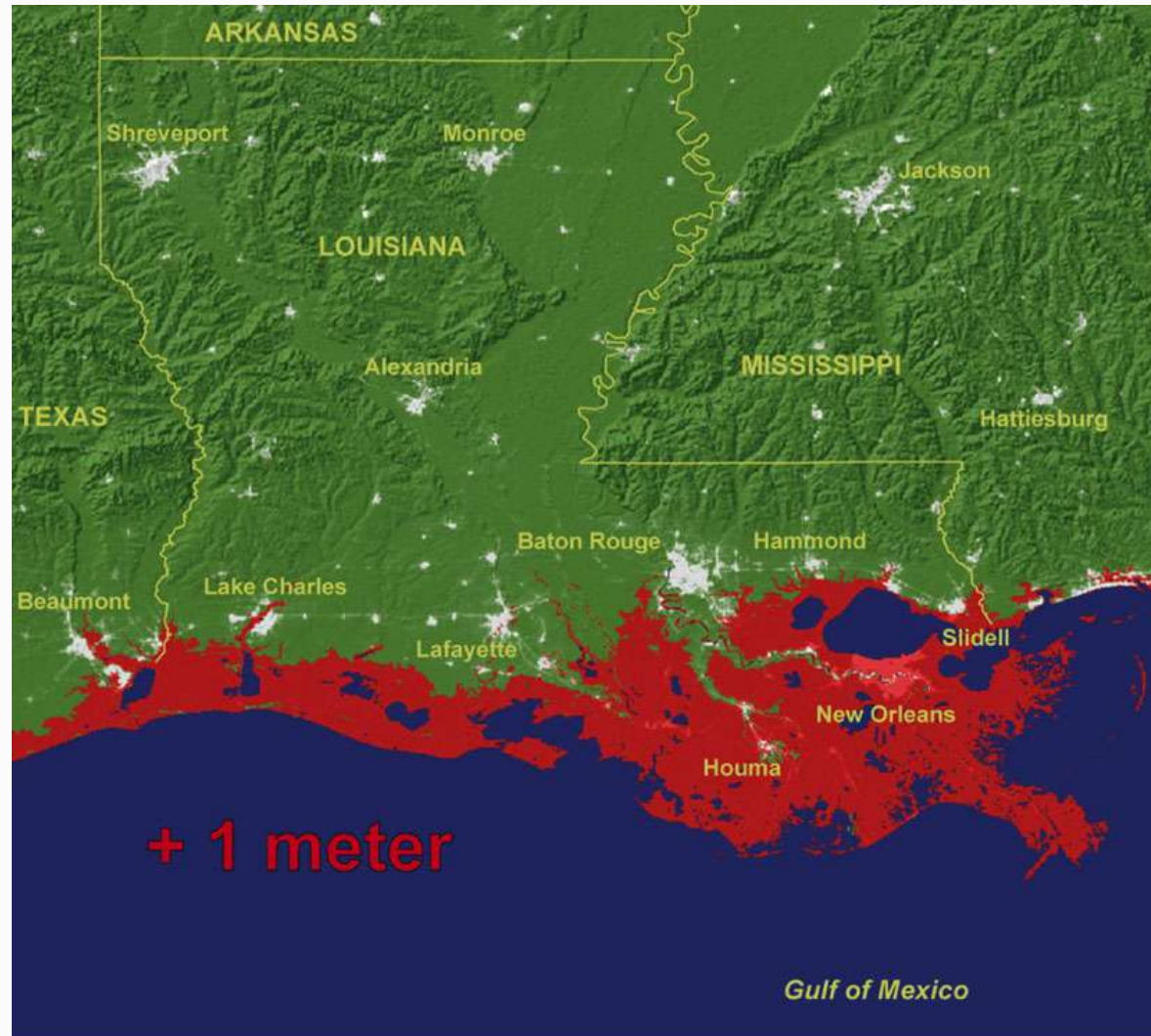
- Coastal deltas, mangrove forests, and coastal wetlands: natural protection against storms
 - Dams and levees reduce sediments in deltas: significance?
 - New Orleans, Louisiana, and Hurricane Katrina: August 29, 2005
 - Global warming, sea rise, and New Orleans
-

New Orleans, Louisiana, (U.S.) and Hurricane Katrina



© Brooks/Cole, Cengage Learning

Projection of New Orleans if the Sea Level Rises 0.9 Meter



Freshwater Inland Wetlands Are Vital Sponges (1)

- Inland Wetland: lands covered with water all or part of the year
 - Marshes
 - Grasses, reeds, few trees
 - Swamps
 - Trees & shrubs
 - Prairie potholes
 - Floodplains
 - Arctic tundra in summer
-

Freshwater Inland Wetlands Are Vital Sponges (2)

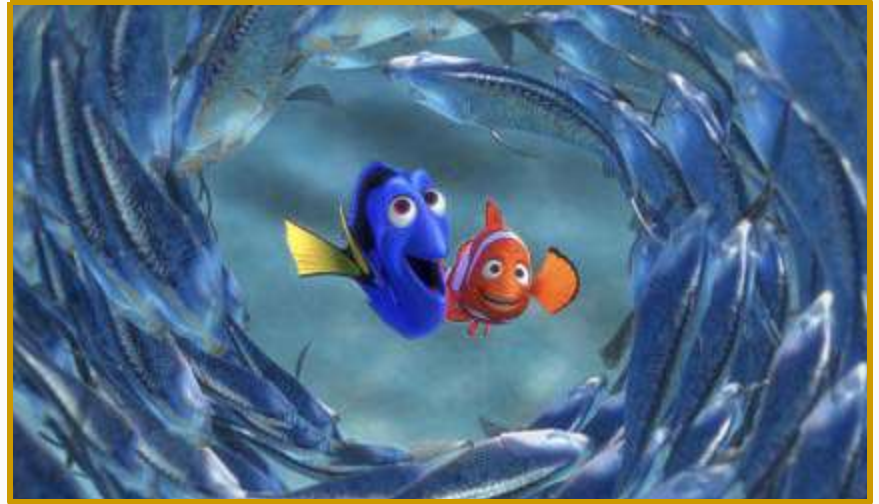
- Provide free ecological and economic services
 - Filter and degrade toxic wastes
 - Reduce flooding and erosion
 - Help to replenish streams and recharge groundwater aquifers
 - Biodiversity
 - Food and timber
 - Recreation areas
-

Human Activities Are Disrupting and Degrading Freshwater Systems

- Impact of dams and canals on rivers
 - Alter or destroy habitats
 - Impact of flood control levees and dikes along rivers
 - Reduce healthy function of wetlands
 - Impact of pollutants from cities and farms on rivers
 - Eutrophication
 - Impact of drained wetlands
 - Flood & drought
-

Case Study: Inland Wetland Losses in the United States

- Half the U.S.'s natural wetlands have been lost
 - Growing crops (80%)
 - Mining
 - Forestry
 - Oil and gas extraction
 - Building highways
 - Urban development
-



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PART 4: MARINE LIFE ZONES (8.2 & 8.3)

Major Ecological and Economic Services Provided by Marine Systems

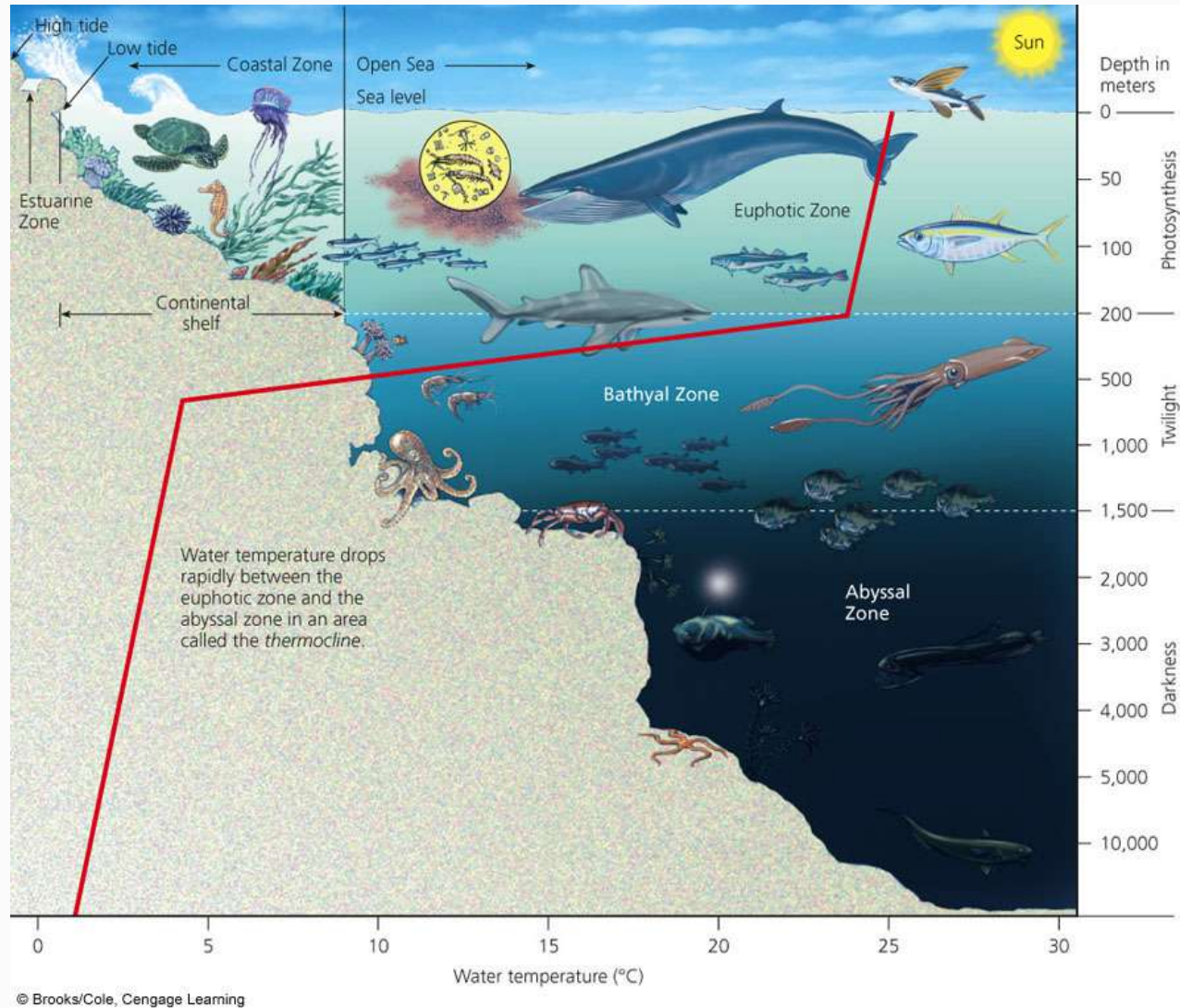


Goods & Services
valued at over
\$12 trillion
per year!

Oceans Provide Important Ecological and Economic Resources

- Reservoirs of diversity in three major life zones
 - Coastal zone
 - Usually high NPP
 - Open sea
 - Ocean bottom
-

Natural Capital: Major Life Zones and Vertical Zones in an Ocean



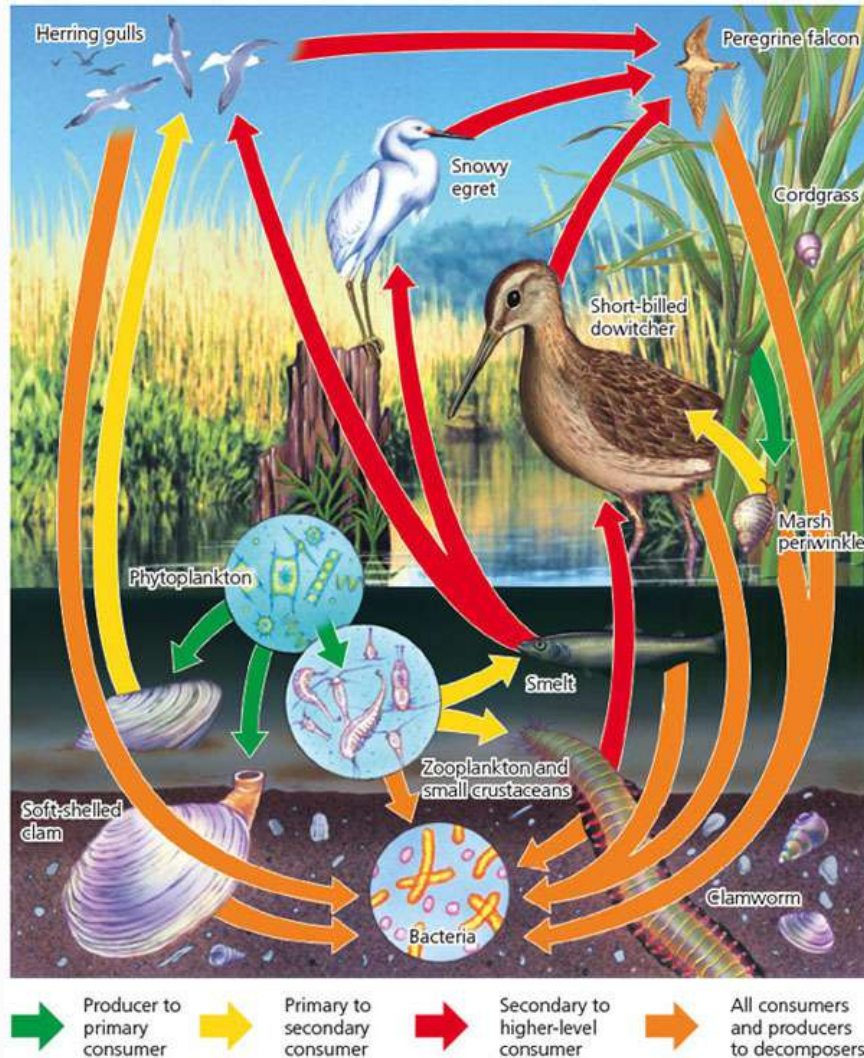
Coastal Zones

- Coastal zone
 - Warm, nutrient rich, shallow, ample sunlight
 - From high tide to edge of continental shelf
 - Less than 10% area, over 90% of species
 - Estuaries
 - Coastal Wetlands
 - Tidal Zones
-

Estuaries and Coastal Wetlands Are Highly Productive (1)

- **Estuaries and coastal wetlands**
 - **Areas where the river meets the sea - brackish**
 - River mouths
 - Inlets
 - Bays
 - Sounds
 - Salt marshes (temperate)
 - Mangrove forests (tropical)
 - **Seagrass Beds**
 - Support a variety of marine species
 - Stabilize shorelines
 - Reduce wave impact
-

Some Components and Interactions in a Salt Marsh Ecosystem in a Temperate Area



View of an Estuary from Space



© Brooks/Cole, Cengage Learning

Estuaries and Coastal Wetlands Are Highly Productive (2)

- Important ecological and 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
 - Loss of mangroves leads to salt water intrusion
-

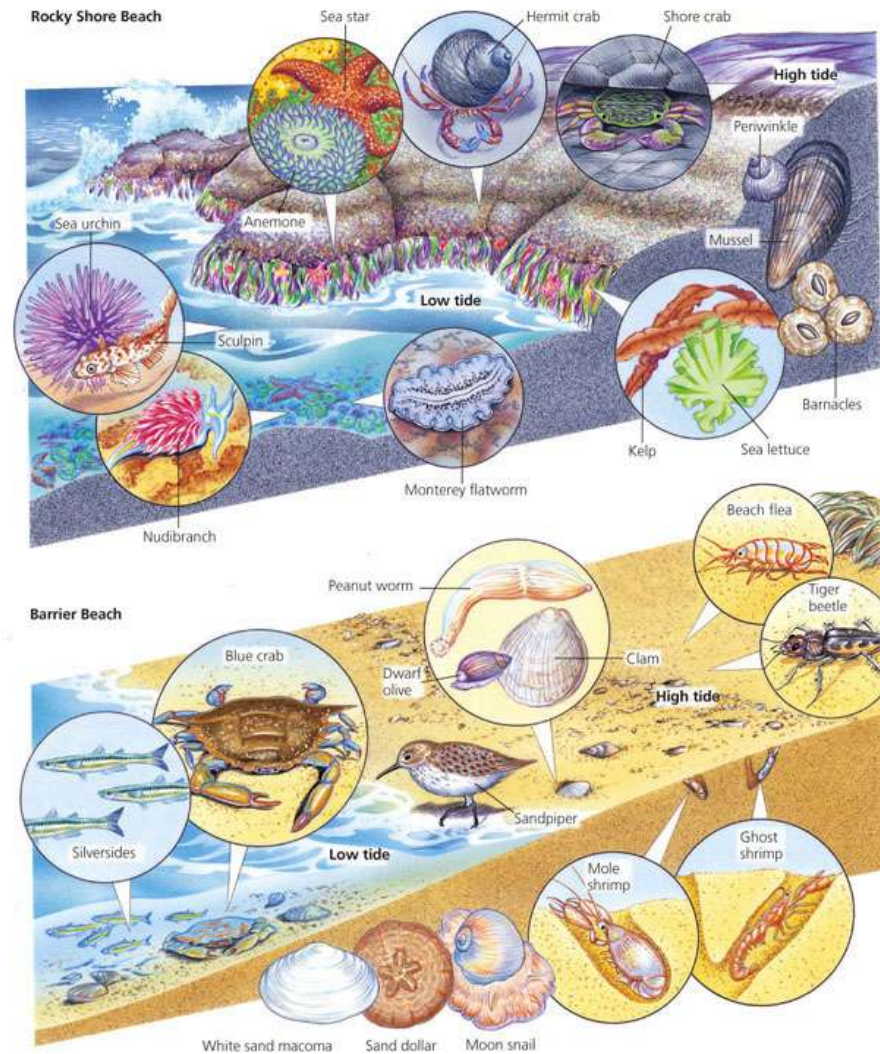
Mangrove Forest in Daintree National Park in Queensland, Australia



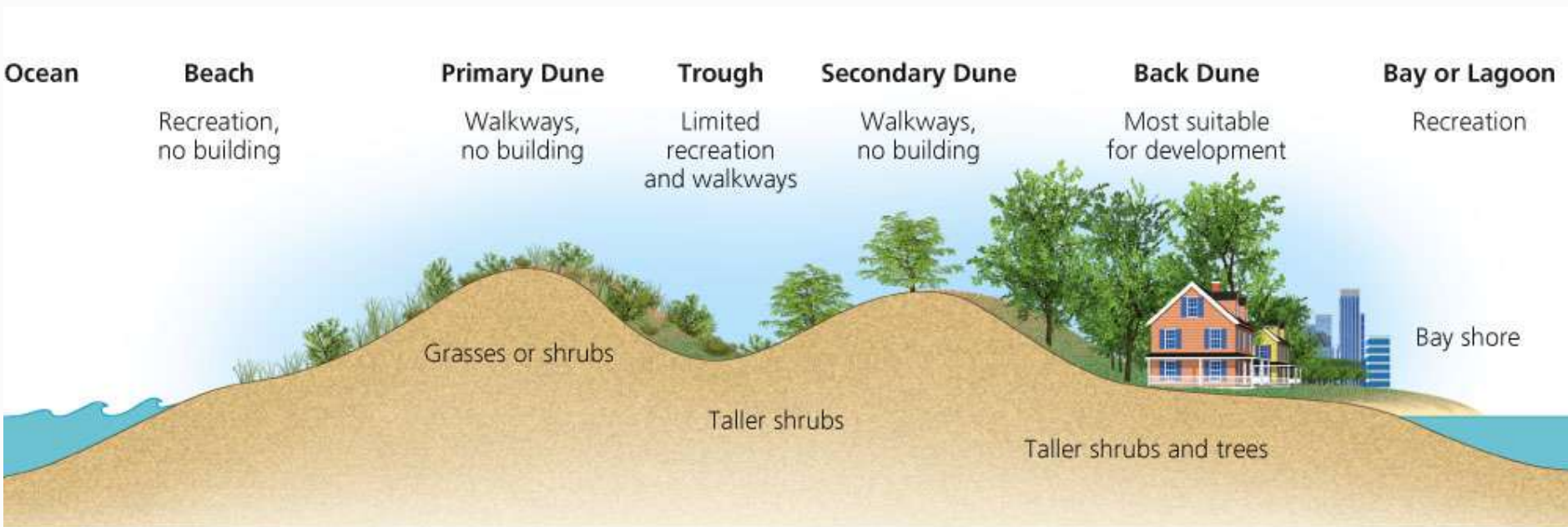
Rocky and Sandy Shores Host Different Types of Organisms

- **Tides caused by pull of moon and sun**
 - Usually about every 6 hours
 - **Intertidal zone**
 - Rocky shores
 - Sandy shores/barrier beaches
 - Different from barrier islands
 - Organism adaptations necessary to deal with daily salinity, moisture & temperature changes
 - Burrow or hide in shells
 - Importance of sand dunes in erosion prevention
-

Living between the Tides



Primary and Secondary Dunes



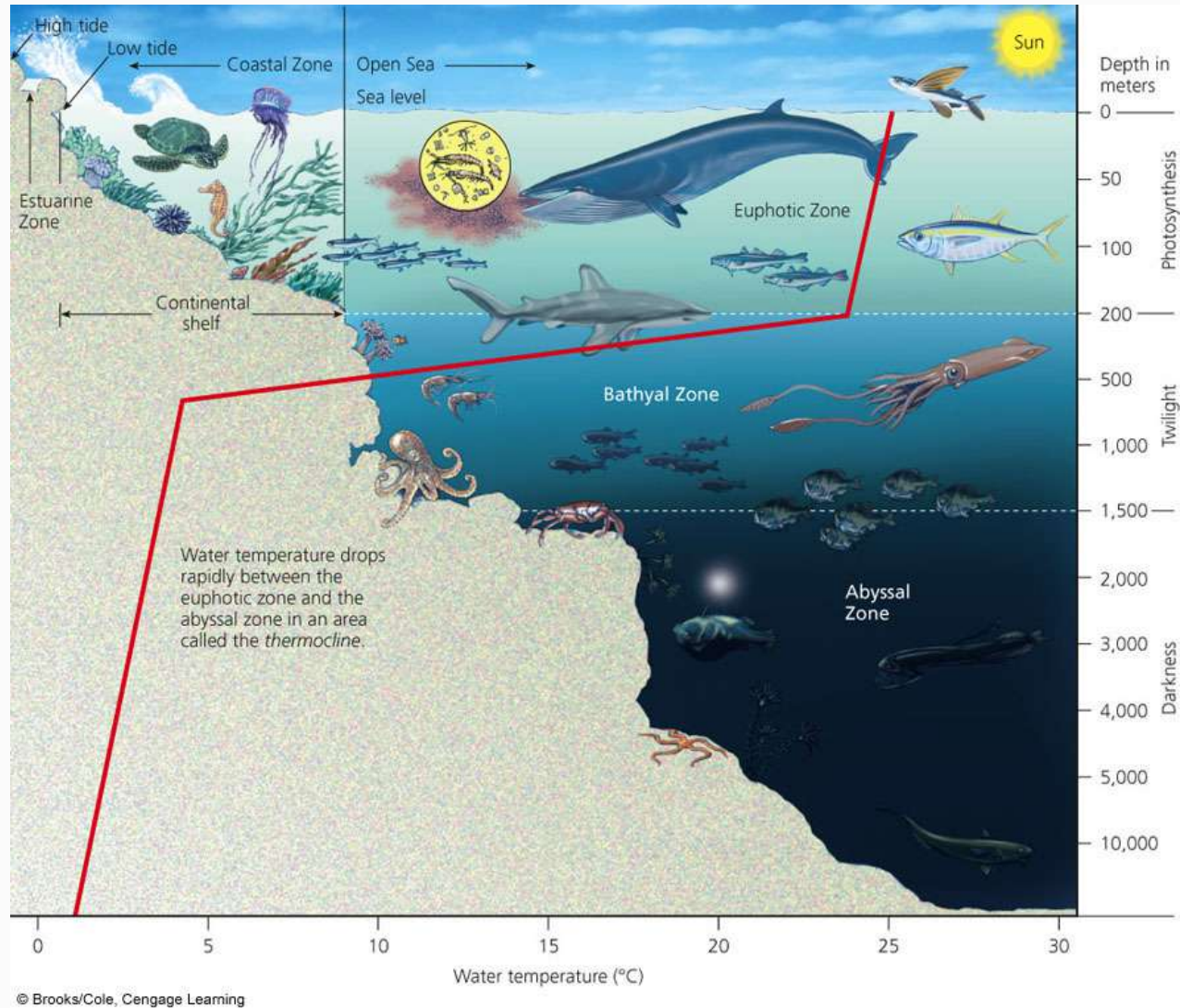
Coral Reefs Are Amazing Centers of Biodiversity

- 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

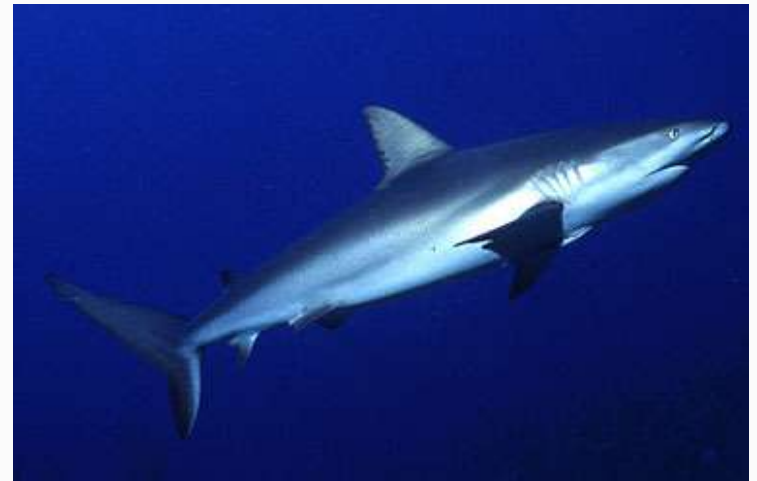
- Vertical zones of the open sea
 - **Major difference - Sunlight**
 - **Euphotic zone**
 - 40% of world's photosynthesis
 - **Bathyal zone**
 - **Abyssal zone:** receives **marine snow**
 - Deposit feeders (mud)
 - Filter feeders (water)
 - **Upwellings**
 - Primary productivity and NPP
-

Natural Capital: Major Life Zones and Vertical Zones in an Ocean



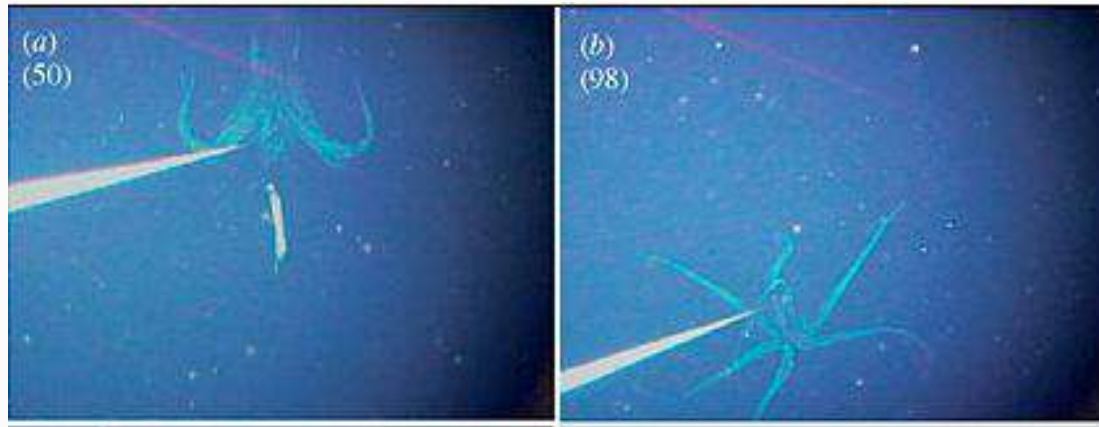
The Euphotic Zone (Sunlight Zone)

- Home to a wide variety of species
 - sharks, tuna, mackerel, jellyfish, sea turtles, seals and sea lions and stingrays.
- Water temperatures are relatively warm
- Adaptations
 - Counter-shading
 - Some animals are dark on the top and lighter on their undersides



The Bathyal Zone (Twilight Zone)

- Animals must be able to survive cold temperatures, an increase in water pressure and dark waters.
 - Octopus, squid, and the hatchet fish are some of the animals that can be found in this zone.
- Adaptations
 - Thin bodies that help them hide from predators.
 - Red or black in color to blend in with the dark water
 - Large eyes that help them see in the dark waters.



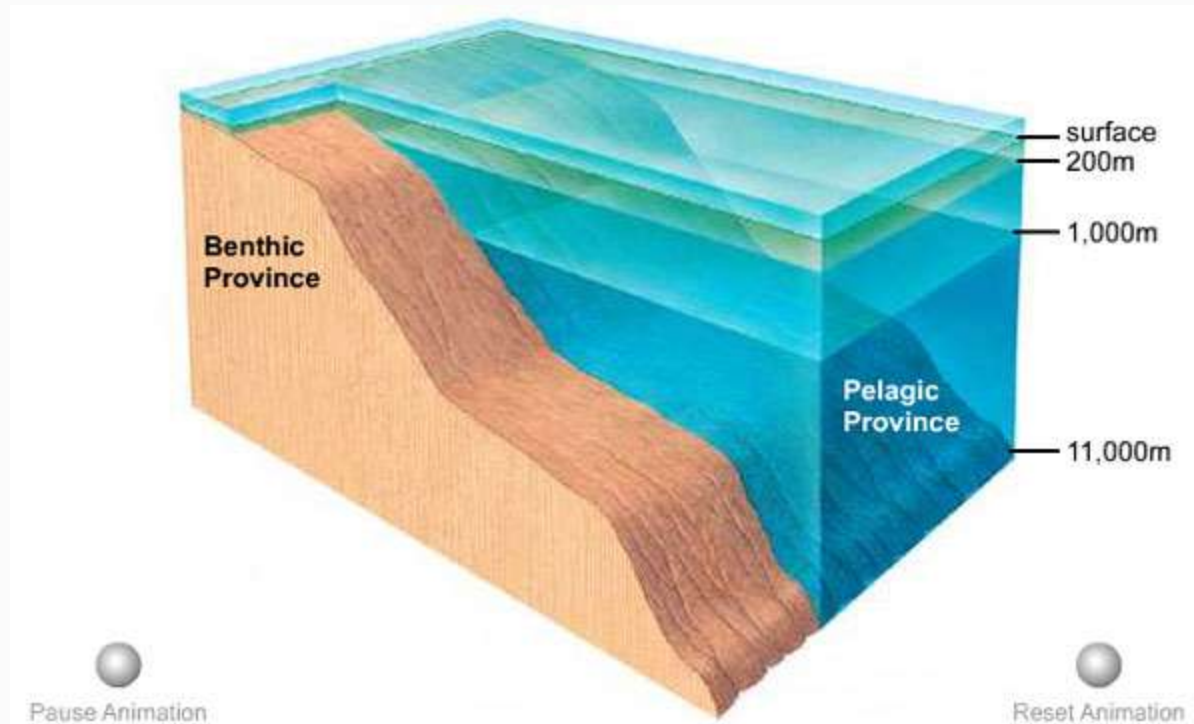
The Abyss (Midnight Zone)

- Cold and completely dark with intense water pressure
- Adaptations
 - Some animals don't have eyes.
 - Most of the fish in this zone don't chase their food.
 - They either stalk it or wait for it to float or swim by.
 - **Bioluminescence** – animals that make their own light



Colobonema

Animation: Ocean provinces



https://smartsite.ucdavis.edu/access/content/user/00002950/bis10v/media/ch31/ocean_zones.swf

Human Activities Are Disrupting and Degrading Marine Systems

- Human activity heavily affects 41% of the ocean
 - No ocean area is completely unaffected
 - In 2006, 45% of the world's population lived on or near the coast
-

Human Activities Are Disrupting and Degrading Marine Systems

- Major threats to marine systems
 - Coastal development
 - Overfishing
 - 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
-