

A stylized, light green illustration of a plant with several large, pointed leaves and a cluster of small, round buds or flowers on a stem, positioned on the left side of the slide against a dark green background.

## 1.3 AQUATIC BIOMES

**Enduring Understanding:** Ecosystems are the result of biotic and abiotic interactions.

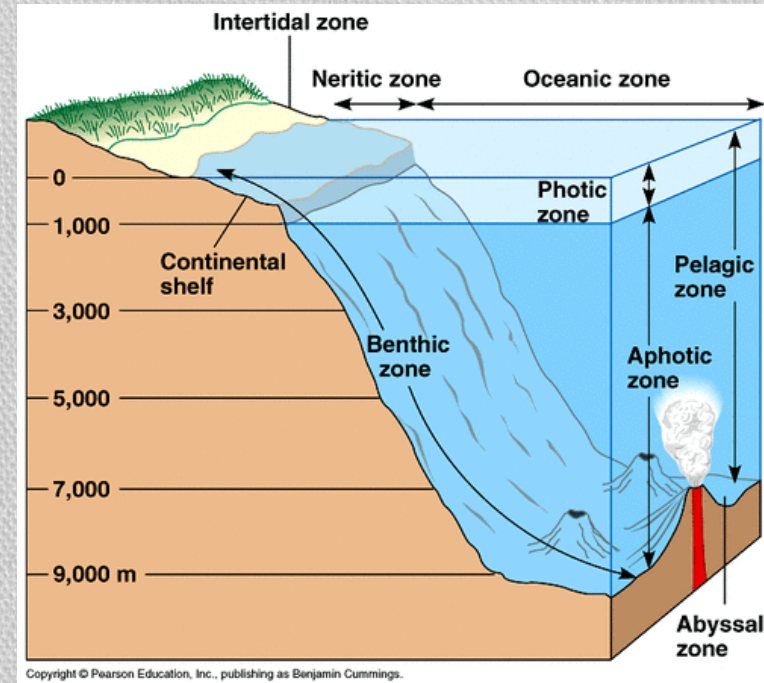
**Learning Objective:** Describe the distribution and principal environmental aspects of aquatic biomes

# Aquatic Biomes

- **Water covers  $\approx$  70% of Earth's surface, so aquatic biomes are a major component of the global environment.**
- **Aquatic biomes are those that are dominated by the presence of water.**
  - Deep oceans, shallow seas and reefs, swamps, estuaries, and rivers and lakes.
  - Like terrestrial biomes, physical conditions determine the distribution of aquatic biomes.
    - However, climate is less of a factor for aquatic biome distribution.
- **Aquatic biomes are broadly broken into two categories; Marine and freshwater biomes**
- **Marine Biomes**
  - Marine Biomes are heavily influenced by light, temperature, density, salinity, tides, currents, and wave action
  - Open ocean and deep seas, continental shelves, reefs (several types), kelp forests, and estuaries
- **Freshwater Biomes**
  - Freshwater biomes are heavily influenced by geologic formation and topography
  - Wetlands are highly varied and described by soil type, vegetation, and hydrology
  - Examples: Streams, rivers, lakes, wetlands

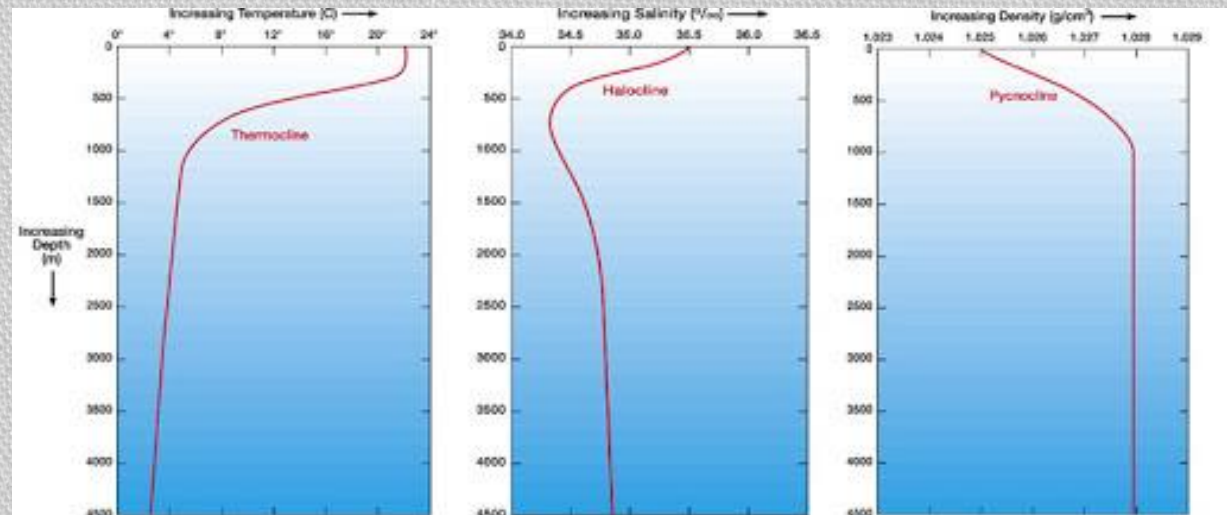
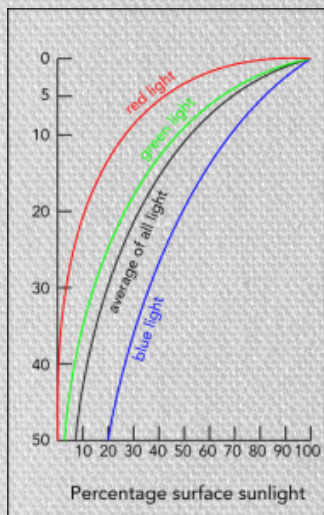
# Oceanic Zones (“Marine Biomes”)

- **Intertidal Zone:** Zone from high tide line to low tide. Heavily influenced by tides, wave action, and substrate
- **Neritic Zone:** The region of water above the continental shelf where light penetrates to the ocean floor. Most productive region of oceans due to high amounts of light and nutrients.
- **Oceanic Zone:** Region of the ocean beyond the continental shelves. Includes the majority of the oceans volumes.
- **Photic Zone:** Region of the ocean that sunlight is able to penetrate (uppermost  $\approx 200\text{m}$ ) although only the top most  $\approx 80\text{m}$  receives enough sunlight to allow photosynthesis.
- **Aphotic Zone:** Region of the zone ocean below the photic zone. Zone where light does not penetrate and is in perpetual darkness. ( $\approx 80\%$  of oceans volume)
- **Benthic Zone:** The sea floor, including the sediment surface and some sub-surface layers. Organisms living in this zone include microorganisms as well as larger invertebrates, such as crustaceans. Many organisms here are permanently attached to the bottom.



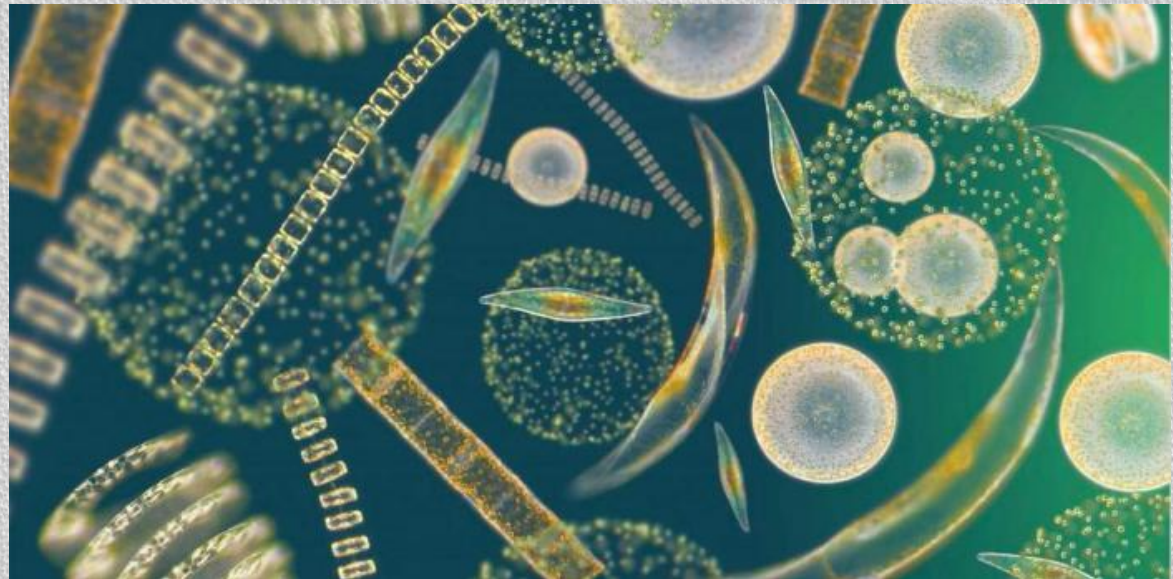
# Oceanic Zones (“Marine Biomes”)

- Although the open ocean may appear quite uniform, conditions vary considerably with depth.
  - This is called **stratification**
- Light, Temperature, salinity and depth influence oceanic zones
- Most marine life is found in regions where light penetrates deeply enough to support photosynthesis.
- Light also helps warm surface waters. Increasing depth, sharply decreases temperature (**thermocline**). Salinity shows a similar pattern (**halocline**)
- As a result of these patterns of temperature and salinity, density shows the opposite trend, rapidly increasing with depth. (**pycnocline**)



# Open-ocean ecosystems vary in biodiversity

- **Microscopic phytoplankton are the base of the marine food chain**
  - Productivity is concentrated in areas of nutrient-rich upwelling
  - Phytoplankton (algae, protists, and cyanobacteria) feed zooplankton, which then feed fish, jellyfish, whales, etc.
- **Predators at higher trophic levels**
  - Larger fish, sea turtles, sharks, and fish-eating birds
- **Animals of the deep ocean have adapted to extreme water pressure and the dark**
  - Most food webs of the deep ocean are driven by detritus that drifts down from above (“marine snow”)



# **Coastal and Near Shore Marine Ecosystems (“Marine Biomes”)**

# Salt Marshes Line Temperate Shores

- **Salt marshes occur along coasts at temperate latitudes**
  - Rising and falling tides flow into and out of channels called tidal creeks and overflow onto marsh flats
  - Tides wash over gently sloping sandy, silty substrates
- **Salt marshes have very high primary productivity**
  - Thick with salt-tolerant grasses, sedges, shrubs
  - Critical habitat for birds, commercial fish, and shellfish
  - They filter pollution
  - They stabilize shorelines against storm surges



# Mangrove Forests Line Coasts in the tropics and Subtropics

- *Mangrove forests* replace salt marshes along sandy coasts at tropical and subtropical latitudes
  - Mangrove trees are salt-tolerant and can live in changing water levels
  - Their unique roots curve up for oxygen and down for support
- Provide nesting areas for birds, nurseries for fish and shellfish, provide food and medicine, Slow runoff, filter pollutants, retain soil, protect communities against storm surges
  - Half the world's mangrove forests are gone; developed for residential, commercial, and recreational uses





# Freshwater Meets Saltwater in Estuaries

- **Estuaries** are water bodies where rivers flow into the ocean, mixing fresh and salt water
  - They are biologically productive
  - Have fluctuations in salinity and water level as tides move in and out
- Critical habitat
  - For shorebirds and shellfish
  - Transitional zone for fish that spawn in streams and mature in salt water
  - Protect neighboring communities from flooding and storm surge



# Kelp forests harbor many organisms

- Kelp are large, dense, brown algae growing from the floor of continental shelves
  - Can reach 60 m (200 ft) long and grow 45 cm (18 in) per day
  - Dense strands form kelp forests along temperate coasts
  - They provide shelter and food for organisms
  - They absorb wave energy and protect shorelines from erosion
- People use kelp in food, cosmetics, paints, paper, soap, etc.



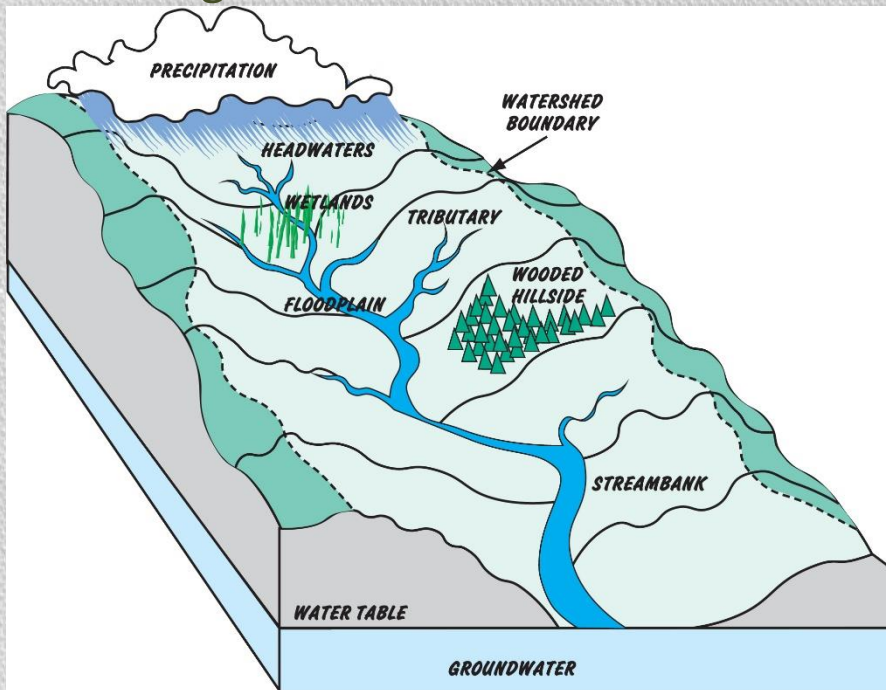
# Coral Reefs Are a Treasure Trove of Biodiversity

- **Coral reefs** are a mass of calcium carbonate ( $\text{CaCO}_3$ ) composed of the skeletons of tiny marine animals (corals)
  - Live in shallow subtropical/tropical waters located
  - May be an extension of a shoreline
  - Or exist along a *barrier island*, parallel to the shore
  - Or as an *atoll* (a ring around a submerged island)
- **Corals** are tiny colonial invertebrate animals related to sea anemones and jellyfish
  - New corals grow on top of the skeletons of old corals; increasing the size of coral reefs
  - Attach to a rocky reef and capture some passing food with stinging tentacles
  - However they get the majority of their nourishment from symbiotic algae (*zooxanthellae*) that grow on their surface
  - Colors come from the zooxanthellae algae
- High primary productivity
- Reefs protect shorelines by absorbing waves



# Freshwater Ecosystems (“Freshwater Biomes”)

- Only 2.5% of water on earth is considered freshwater, of that small amount of freshwater, only 1% is easily accessible surface freshwater (only 0.025% of all water on earth).
- Sources of fresh, surface water are vitally important for irrigation and drinking water.



- The type and location of freshwater ecosystems is largely determined by the topography of the surrounding landscape.
- Freshwater systems form *watersheds*.
- Freshwater ecosystems differ from one another due to differences in current as well as differences in dissolved oxygen and nutrients.
- As precipitation falls on land, it runs down hill and collects in low lying areas. This forms **streams** that carry water further downhill where they merge into larger **rivers**, which may pool into **lakes**, before eventually flowing to the oceans.
- Along the banks of rivers and lakes, as well as in other low-lying areas, **wetlands** may form where standing water saturates the soil.

# Streams and Rivers

- At higher elevations within a watershed, surface runoff collects into small bodies of water known as *streams*
  - Generally lower volumes of water, but faster moving due to the steeper gradient of the surrounding hills or mountains
    - High sediment loads, high dissolved oxygen, generally low nutrient levels, colder temperature
  - Further down the watershed, streams converge into larger *rivers* in the valley(s) of the watershed.
    - Higher up rivers and streams move rapidly carrying large sediment loads and generally form *braided rivers*
    - As they slow in the valleys, sediment is deposited along the banks, forming *floodplains*, with a *meandering river* flowing through.
    - Over time, river bends of a meandering river become exaggerated, and sediments deposited by the river can cause it to change course forming *oxbows*.
  - Generally, further down river, currents slow, volume increases, sediments are deposited, nutrients increase, temperature increases, and dissolved oxygen decreases.



(a) Braided river in Nebraska



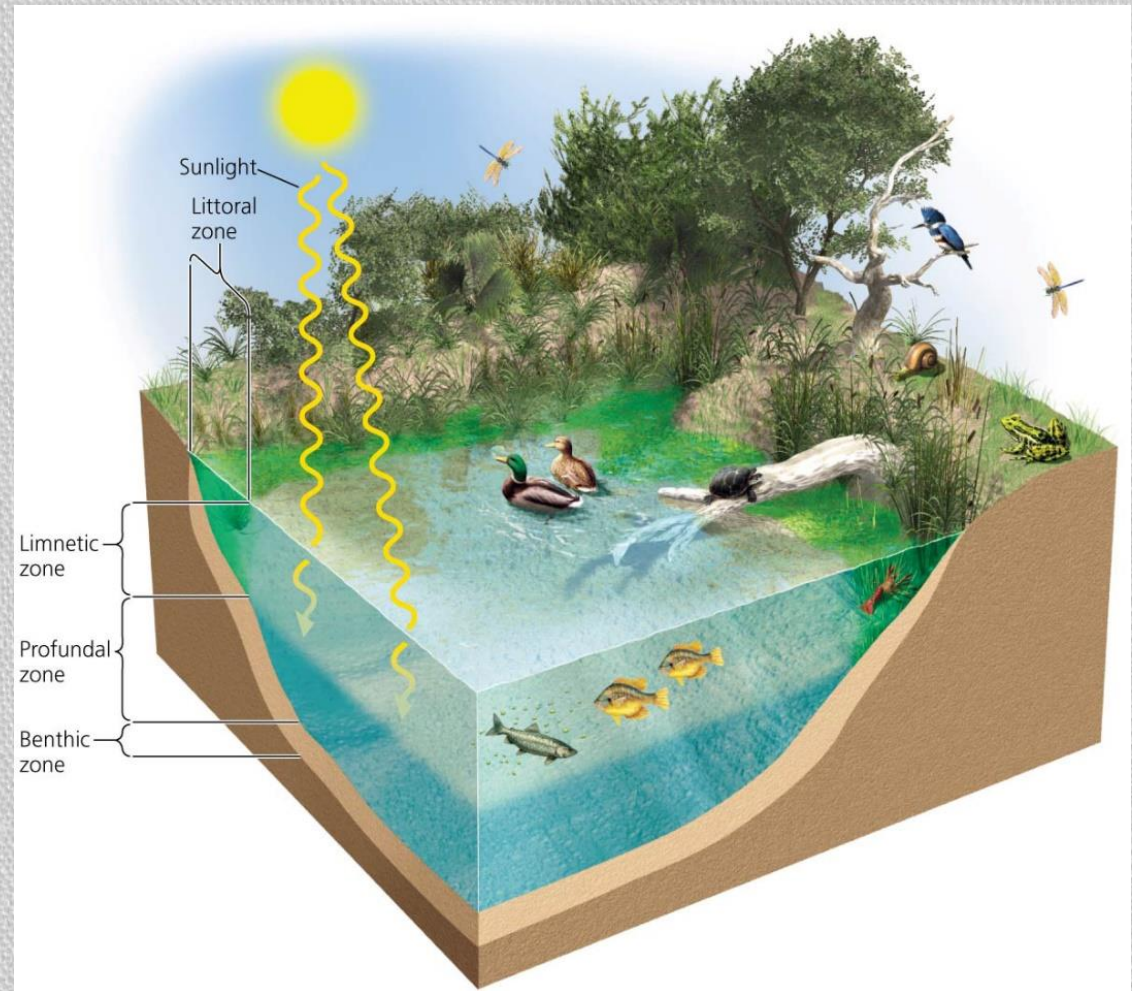
(b) Meandering river in Alaska



(c) Oxbow river in Arizona

# Lakes and ponds are ecologically diverse systems

- Lakes and ponds are bodies of open, standing water
  - **Littoral zone** is the region ringing the edge of a water body
    - Rooted aquatic plants grow in this shallow part
  - **Benthic zone** is the entire bottom of the water body
    - Home to many invertebrates
  - **Profundal zone** is the zone of water that sunlight does not reach
    - Supports fewer animals because there is less oxygen



- **Limnetic zone** is the open portion of the lake or pond where sunlight allows photosynthesis that produces oxygen
  - Supports phytoplankton and zooplankton

# Lakes and Ponds are Diverse Ecosystems

- **Ponds and lakes may change over time**
  - *Oligotrophic* lakes and ponds have low-nutrient and high-oxygen conditions
  - *Eutrophic* lakes and ponds have high-nutrient and low-oxygen conditions
    - Eutrophication may result from human pollution
- **Eventually, water bodies may fill completely in through the process of succession**
- **The largest lakes are known as inland seas**
  - The *Caspian Sea* (largest surface area, but salty), *Lake Superior* (largest freshwater surface area), *Lake Baikal* (largest volume, 20% of all freshwater worldwide, equal volume to the total in all great lakes)



# Freshwater wetlands include marshes, swamps, bogs, and vernal pools

- **Wetlands** are systems in which the soil is saturated with shallow standing water with vegetation
  - **Freshwater Marshes**
    - A marsh is a wetland dominated by herbaceous plants such as grasses, rushes, or sedges. Small shrubs often grow along the perimeter as a transition to drier land. Marshes usually form along the shallow edges of lakes and rivers.
  - **Bogs**
    - Bogs are acidic, low-oxygen wetlands that form where accumulation of organic material occurs faster than organic decay. Bog soils are waterlogged and acidic peats formed by sphagnum moss and other vegetation that decomposes very slowly.
  - **Swamps**
    - Swamps are forested wetlands, characterized by specific types of trees and soil types.
  - **Vernal Pools**
    - Vernal pools are small, temporary wetlands that generally fill during spring or fall and dry up in summer. One essential characteristic is that they lack fish, which makes them safe breeding habitat for certain species of amphibians and wetland invertebrates such as fairy shrimp that would otherwise become fish prey.



Marsh



Swamp



Bog



Vernal Pool



# Freshwater wetlands include marshes, swamps, bogs, and vernal pools

- **Wetlands are extremely valuable for wildlife**
  - Louisiana's coastal wetlands host 1.8 million migratory birds each year
- **They provide valuable ecosystem services**
  - They slow runoff, reduce flooding, recharge aquifers, and filter pollutants
- **People have drained wetlands, mostly for agriculture**
  - Southern Canada and the United States have lost over half of their wetlands
- **Wetlands are affected when we withdraw water, build dams and levees, and introduce pollution**