Freshwater and Marine Ecosystem
Composition of Water on Earth

Aquatic Life Zones

1. Aquatic Life Zone: biomes of water
2. Saltwater versus Freshwater
3. Distribution of organisms is determined by salinity (Salt content) of water
4. Saltwater (marine) life zones include:
   - Oceans & bays
   - Estuaries
   - Coastal wetlands
   - Shorelines
   - Coral reefs
   - Mangrove forests
5. Freshwater life zones include:
   - Lakes and ponds
   - Rivers and streams
   - Inland wetlands
Freshwater Ecosystem

- Freshwater ecosystems are a subset of Earth’s aquatic ecosystems.
- Freshwater ecosystems can be divided into lentic ecosystems (still water) and lotic ecosystems (flowing water).

Freshwater ecosystems include moving and standing water.
- A watershed is a region of land that drains into a body of water.
Freshwater Ecosystem

- They include lakes and ponds, rivers, streams, springs, and wetlands.
- They can be contrasted with marine ecosystems, which have a larger salt content.
- Limnology (and its branch freshwater biology) is a study about freshwater ecosystems.

Kinds of freshwater habitats

- Rivers, streams
  - Flowing freshwater
  - Source: where it starts
  - Mouth: where it ends
- Lakes, ponds
- Wetlands
All freshwater ecosystems

• Just a fraction of the Earth’s water
  – .01% = one one-hundredth of one percent
• Occupy less than 1 percent of the Earth’s surface
• What’s the difference?
  – Ponds typically smaller
  – May be seasonal—that is, dry up part of the year
  – Lakes exist hundreds or thousands of years
    • But, even lakes can fill in or dry up

• All lakes “turn over” periodically.
  – Turn over happens due to changes in density.
  – In both autumn and spring, surface water flows downward and bottom water flows upward.
  – The upwelling brings up nutrients.
Zonation of Lakes and Ponds

- **Littoral zone**: near shore
  - Nutrient rich, lots of plant and animal life
  - Warm
- **Limnetic zone**: near surface, open water
  - Lots of light
  - Lots of plankton
- **Profundal zone**: deeper, little light
- **Benthic zone**: the bottom, little light, low oxygen
Littoral zone

- It is nutrient rich and found near the shore.
- Aquatic life is diverse and abundant.
- Plants such as cattails and reeds, are rooted in the mud underwater, and their upper leaves and stems emerge above the water. Plants that have floating leaves, such as pond lilies, are rooted here.

Lakes and Ponds

- In the open water (limnetic zone), plants, algae, and some bacteria capture solar energy to make their own food during photosynthesis.
- Some bodies of fresh water have areas so deep that there is too little light for photosynthesis. Bacteria live in the deep areas of the fresh water to decompose dead plants and animals that drift down from the land and water above.
- Fish adapted to cooler, darker water also live here. Eventually, dead and decaying organisms reach the benthic zone, the bottom of a pond or a lake, which is inhabited by decomposers, insect larvae, and clams.
Zones of a Lake

Littoral Zone

1. Top zone near the shore
2. Consists of shallow, sunlit waters to depth at which rooted plants stop growing
3. High biodiversity because of ample sunlight & nutrient input from surrounding land
4. Organisms consists of: rooted plants, turtles, frogs, crayfish, bass, perch, and carp
**Limnetic Zone**

1. Open, sunlit surface layer away from the shore
2. Extends to depth penetrated by sunlight
3. Main photosynthetic zone; produces food and $O_2$ that support the consumers
4. Most abundant organisms are phytoplankton & zooplankton
5. Large species of fish live here

**Profundal Zone**

1. Layer of deep, open water where it is too dark for photosynthesis
2. Cell Respiration occurs in all layers; this is a layer of oxygen consumption; $O_2$ levels low
3. Fish are adapted to cooler, darker water
Benthic Zone

1. Bottom layer
2. Decomposers, detritus feeders & some benthos fish live here
3. Nutrients come from dead organic matter from littoral & limnetic zones & sediments washed into lake
Eutrophication

• If nutrients increase too much in a lake, pond, or ocean, excessive plant growth results
• Phosphorus
• Nitrogen
• NOT GOOD: why?
  – As plants decay, decomposing bacteria use oxygen dissolved in the lake to do their jobs.
  – Dissolved oxygen goes down

Eutrophication is an increase in the amount of nutrients in an aquatic ecosystem. A lake that has large amount of plant growth due to nutrients, is known as a eutrophic lake.

• As the amount of plants and algae grows, the number of bacteria feeding on the decaying organisms also grows. These bacteria use the oxygen dissolved in the lake’s waters. Eventually, the reduced amount of oxygen kills oxygen loving organisms.
Eutrophic lakes

1. “Oligo” means very little; have very little nutrients (N & P)
2. Deep and has steep banks
3. Glaciers & mountain streams supply water
4. Not much sediment brought into lake
5. Clear water; not much algae
6. Rocky or sandy bottom
7. Fish include small mouth bass and trout
8. Little photosynthesis so low primary productivity

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**Eutrophic Lake**

1. Truly nutrient rich (N & P)
2. Shallow and have murky water and mucky, soft bottoms.
3. Also have a lot of plants and algae
4. Nutrients support high densities of algae, fish and other aquatic organisms
5. With all of the biomass, there is a lot of decomposition occurring at the bottom which uses up O$_2$
6. Decomposition uses up O$_2$ causing the bottom of the lake to become anoxic (dePLETED OF O$_2$) causing fish kills

**Mesotrophic Lake**

1. Meso means middle; medium amount of nutrients (N & P)
2. Algae carry out photosynthesis; supply O$_2$ for fish
3. Fish include sport fish such as walleye, perch, and smallmouth bass
Freshwater wetlands

Marsh

Swamp

Wetlands
**Wetlands: what are they?**

• "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

• Wetlands are among the most productive ecosystems.
  – Little flowing water – “standing water”
  – provide a home for many species
  – filter dirty water
  – renew underground water supply

• Some animals have adaptations suited to the freshwater they inhabit.
  • ex: streamlined bodies, hooks and suckers are found on many river organisms.
Wetlands

- May be fresh or brackish
- Freshwater types include:
  - Marsh
  - Swamp
  - Bog
  - Fen

Marsh

- Occur along streams or in depressions
- Characterized by organic, wet soils and non-woody (i.e., no trees) vegetation.
• Freshwater marshes tend to occur on low, flat lands, and have little water movement. In shallow waters plants such as reeds, rushes, and cattails, root themselves in the rich bottom sediments. The leaves of these and other plants stick out above the surface of the water year-round.

• The benthic zones of marshes are rich in nutrients and contain plants, numerous types of decomposers, and scavengers.
Swamp

- Wetland dominated by woody plants

Swamps

- Swamps occur on flat, poorly drained land often near streams. Swamps are dominated by woody shrubs or water loving trees, depending on the latitude and climate in which the swamps are located.
- Mangrove swamps occur in warm latitudes near the ocean, so their water is salty.

The American alligator living in a swamp
Swamps

- Freshwater swamps are the ideal habitat for many amphibians, such as the frogs and salamanders, because of the continuously moist environment.
- Swamps also attract birds, such as wood ducks, that nest in hollow trees near or over the water. Reptiles, such as the American Alligator are the predators of swamps and will eat almost any organism that crosses their path.

Rivers

- Many rivers originate from snowmelt in mountains. At its headwaters, a river is usually cold and full of oxygen and runs swiftly through a shallow riverbed. As a river flows down a mountain, a river may broaden, become warmer, wider, and slower, and decrease in oxygen.
- A river changes with the land and the climate through which it flows. Runoff, for example, may wash nutrients and sediments from the surrounding land into a river. These nutrients affect the growth and health of the organisms in the river.
Narrow headwaters

Estuary Ecosystems

- **Estuaries** - shallow areas where fresh water and salt water mix (brackish) both freshwater and marine animals live here. Estuaries make up 10% of the marine biome but hold 90% of marine life. Main nesting areas for migratory birds and spawning ground for marine animals.
Estuaries are dynamic environments where rivers flow into the ocean.

• An estuary is a partially enclosed body of water.
  – mixture of fresh water with salt water

• Estuaries are highly productive ecosystems.

  • Estuaries provide a protected refuge for many species:
  • Ex: photo. Org., decomposers, phyto and zooplankton
    – birds migration – stop over point
    – spawning grounds for fish
  • Estuaries are primarily threatened by land development.
Marine Ecosystems

- **Marine biome**: saltwater environment that includes the oceans and their shorelines. Covers 70% of the earth’s surface. Varied physical conditions with depth.

- **Marine Zones**: classified by water depth, presence of light & distance from shore

The Oceans

1. The ocean is divided into 5 oceans (Southern Ocean was added in 2000)
2. Pacific ocean is the largest; more than ½ of Earth’s water & covers ⅓ of Earth’s surface
3. Oceans have changed over time due to plate tectonics
Organisms in the Life Zones

1. **Plankton**: weakly swimming, free-floating
   - Phytoplankton: algae
   - Zooplankton: 1° consumers; eat plankton & 2° consumers zooplankton
   - Ultraplankton: very small photosynthetic plankton
     - 70% of primary productivity of ocean

2. **Nekton**: strong swimming consumers such as fish, turtles, & whales

3. **Benthos**: bottom dwellers (sessile); such as oysters & sea stars

4. **Decomposers** (bacteria) break down dead organic matter & waste into nutrients

Groups of aquatic organisms

- Planktons are the organisms that float near the surface of the water. Two types of plankton are microscopic plants called phytoplankton, and microscopic animals called zooplankton. Phytoplankton produce most of the food for an aquatic ecosystem.
Aquatic organisms

- Nekton are free-swimming organisms, such as fish, turtles, and whales.

Benthos

- Benthos are bottom-dwelling organisms, such as mussels, worms, and barnacles. Many benthic organisms live attached to hard surfaces.
Abiotic Factors that Determine types and Numbers of Organisms

1. Salinity (salt concentration)
2. Light penetrates to depth of 30 m (100 ft) below water surface
3. Currents / waves: present or absent
4. Level of essential nutrients: upwelling brings nitrates (NO$_3^-$) and phosphates (PO$_4^{3-}$) from ocean bottom to surface
5. Dissolved oxygen (DO); varies according to temperature and number of consumers
6. pH
7. Temperature; decreases with water depth
1. 3 factors that divide the ocean into marine life zones
   - sunlight
   - distance from shore
   - water depth

Turbidity: degree to which the water loses its transparency due to the presence of suspended particulates. The more turbid, the less sunlight can penetrate through and the less photosynthesis.

The ocean can be divided into zones.
- Ocean zones can be determined by their distance from shoreline and water depths.
  - intertidal zone—between low and high tide
  - neritic zone—from intertidal zone to continental shelf
  - bathyal zone—from neritic zone to base of continental shelf
  - abyssal zone—lies below 2000 m
Marine Ecosystems

• **Intertidal Zone**: band of water at the water’s edge alternately covered by and exposed by water, organisms must be able to adapt to a variety of both temp & salinity.

• **Neritic Zone**: a relatively shallow zone lying above the continental shelf, it is rich in nutrients and light penetrates the bottom allowing for growth of phytoplankton and the animals that depend upon it for food.

• **Bathyal Zone**: extends from edge of the neritic zone to the base of the continental shelf between 200 and 2000 meters.

• **Abyssal Zone**: below 2000 meters, no photosynthesis only chemosynthesis.

### Pelagic and benthic zone divisions

<table>
<thead>
<tr>
<th>Pelagic zone divisions (depth from surface)</th>
<th>Benthic zone divisions (seafloor zones)</th>
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<tbody>
<tr>
<td>Supralittoral – shore above high tide</td>
<td>Littoral – the intertidal zone (sometimes submerged and sometimes above water)</td>
</tr>
<tr>
<td>Epipelagic (0-200m)</td>
<td>Sublittoral – seafloor of the continental shelf (from low tide to the shelf break)</td>
</tr>
<tr>
<td>Mesopelagic (200-1,000m)</td>
<td>Bathyl – seafloor of the continental slope to the deep ocean bottom</td>
</tr>
<tr>
<td>Bathypelagic (1,000-4,000m)</td>
<td>Abyssal – deep ocean bottom between the base of the slope and 6,000 m</td>
</tr>
<tr>
<td>Abyssopelagic (4,000-6,000m)</td>
<td>Hadal – the deepest zone, below 6,000m</td>
</tr>
<tr>
<td>Hadalpelagic (6,000-10,000m)</td>
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</tbody>
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Marine Ecosystems

- The neritic zone harbors more biomass than any other zone.
- Plankton make up most of the biomass.
  - zooplankton
  - phytoplankton

Coastal Zone

1. Characteristics:
   - Warm, nutrient rich shallow water
   - Extends from high tide mark on land to edge of continental shelf
   - Less than 10% of ocean area
   - Contains 90% of all marine species
   - Site of most large commercial fisheries
   - High net primary productivity from photosynthesis

2. Examples
   - Estuaries
   - Coastal marshes
   - Mangrove forests
   - Coral reefs
Coastal waters contain unique habitats.

• Coral reefs are found in warm waters.
  – tropical climate zone
  – great amount of biomass

• Kelp forests are found in cold, nutrient-rich waters.
  – large communities of seaweed
  – great amount of biomass
1. **Mangroves**: trees & shrubs that grow in intertidal zones of estuaries, coastlines, and islands.
2. Form a forest in the tidal zone between land and sea.
3. Found in tropical and subtropical areas
4. Thrive in areas of high salinity
   - Mangrove trees have aerial roots that filter salt out of saltwater
5. Rich in biodiversity! home to countless species of animals, including fish, shrimp, crabs, mollusks, manatees, sea turtles, fishing cats, monitor lizards and mud-skipper fish.

1. “Rainforest of the Sea”
2. Less than 0.1% of ocean surface, but contain 25% of all marine species
3. **Zooxanthella** are single-celled algae that live in the tissues of animals such as corals
   - **Mutualistic** relationship between algae (algae give food & $O_2$ for coral & coral provide protected environment & $CO_2$ for photosynthesis)
   - represents a highly efficient exchange of nutrients in a nutrient-poor environment.
Ecosystem Services Worldwide

- Storm protection
- Waste treatment
- Pollination of crops
- Water supply and purification
- Regulation of weather and climate
- Cultural and aesthetic value
- Medicinal applications
- Habitat for animals
- Carbon storage
- Erosion control
- Soil formation
- Recreation

**Tourism & Recreation**

Coral reefs attract millions of tourists every year, bringing important income to coastal communities. Some countries derive more than half of their gross national product from coral reef industries.

**Food & Fishing**

Coral reefs sustain the fish and shellfish populations that provide proteins for 1 billion people. Reefs are nurseries for many commercially valuable species.

**Coral Reef Ecosystem Services**

Coral reefs provide nearly $400 billion a year to millions of people in economic goods and ecosystem services.

**Coral Reefs**

- Coral reefs act as homes and nurseries for 25% of all marine life.
- Coral reefs are created by many tiny animals called coral polyps.
- Coral reefs are found in over 100 countries.

**Medicine**

Coral reef species are providing new medical compounds and technology to treat serious diseases. More than half of all new cancer drug research is focusing on marine organisms.

**Coastal Protection**

Coral reefs act as natural wave barriers that protect coastal communities and beaches from storm damage.

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Lakó hā salamát!
Maraming salamat!