Aquatic Science Unit 1

Introduction to Freshwater Ecology
Water is essential to life

- Water is essential to the survival of all living things
- No living organism can survive without water
- Humans cannot go for more than several days without water
- The search for life in outer space is often a search for water
Water covers 75% of the earth’s surface.
Water on the earth’s surface

- Oceans - **97%**

- Freshwater – **3%**
  - Atmospheric moisture **0.03%**
  - Glaciers and ice sheets **75%**
  - Groundwater – **24.7%**
  - Lakes, streams and wetlands- **< 0.9%**
Physical and Chemical Properties of Water

- Water is a **universal solvent**
- Water is the only natural substance that exists in all 3 physical states on earth **solid, liquid and gas**
- Pure water has a **neutral pH of 7.0** meaning it is neither acidic nor basic
- Water has a very high surface tension which allows for the movement of water through plants via **capillary action**
Physical and chemical properties of water - 2

- Water has a very high **specific heat** which has a **moderating** effect on climate.
- Solid water (ice) is **less** dense than liquid water which makes ice float.
- Floating ice is crucial for the protection of aquatic life because it **insulates** the water in extreme climates.
What is a freshwater ecosystem?

- A freshwater ecosystem has two components:
  - **biotic** (living organisms)
  - **abiotic** (the non-living environment in which they inhabit)

- Both the biotic and abiotic elements of the ecosystem must be healthy for it to thrive
Why Are Freshwater Ecosystems Important?

- They provide major **ecological** and **economic** benefits
- They are irreplaceable reservoirs of **biodiversity**
Ecological benefits

- Climate **moderation**
- Nutrient **cycling**
- Water treatment
- Flood control
- Groundwater **recharge**
- **Habitat** for many species
- Genetic resources and **biodiversity**
- Scientific information
Economic benefits

- Food
- **Drinking** water
- **Irrigation** water
- Hydroelectricity
- Transportation corridors
- **Recreation**
- Employment
Drainage Basins

- Freshwater ecosystems lie within drainage basins
- Most drainage basins are river basins
- Texas has 23 major river basins
- Waco is in the Brazos River Basin, the longest river within Texas
Watersheds vs drainage basins

- The term “watershed” has a much broader meaning than drainage basin.
- “Drainage basin” refers to the topography that drains water from a geographic area into a single outlet.
- “Watershed” is a broader term that includes the natural habitat and human built environment of the area.
Texas Lakes and Rivers

- Texas has over 10,000 lakes and ponds
  - Only one major lake is natural (*Caddo Lake*)
  - all others are man-made with dams
- Texas has over 11,000 streams and rivers large enough to be named
  - 191,000 miles of streams and rivers
  - Only 40,000 miles are *perennial* (wet year round)
- Texas has 6.3 million acres of *wetlands* (that’s a lot!)
Water flows in some freshwater systems and stands in others

- **Flowing (lotic) systems of freshwater**
  - Streams
  - Rivers

- **Standing (lentic) bodies of freshwater**
  - Lakes
  - Ponds
  - Inland wetlands
**General differences between streams and lakes (lotic and lentic systems)**

<table>
<thead>
<tr>
<th>Streams (lotic)</th>
<th>Lakes (lentic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normally oxygen rich</td>
<td>Oxygen poor at deeper levels</td>
</tr>
<tr>
<td>Shallower</td>
<td>Deeper</td>
</tr>
<tr>
<td>Streams erode channels making them deeper and wider (canyons)</td>
<td>Lakes become shallower from deposited sediments</td>
</tr>
<tr>
<td>Age progression goes from young narrow and shallow stream to mature wider and deeper stream</td>
<td>Age progression goes from lake to marsh or swamp to land</td>
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<tr>
<td>Top and bottom waters generally the same temperature</td>
<td>May have different temperatures from top to bottom</td>
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</tbody>
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Stream order
Stream types

- **Perennial** streams flow year round
Stream types

- **Intermittent** streams become dry for a week or longer each year
  - Many of the streams around Waco are intermittent
Stream types

- **Ephemeral** streams flow only following rainfall and cease to flow shortly after.
Gaining and losing streams

- Streams can gain water from the ground, usually fed by springs or groundwater (gaining stream)
- Streams can lose water to the ground through percolation (losing stream)
Stream habitat types

- **Erosional** streams are characterized by fast moving water and little sediment
Stream habitat types -2

- **Depositional** streams are slow moving, meandering, and deposit sediment
Streams can have both **erosional zones** and **depositional zones** at the same time.
Stream habitats – 4

- A **riparian zone** is a vegetated buffer between streams and nearby lands. A riparian zone is often heavily wooded.
Formation of lentic systems (lakes, ponds, and wetlands)

- In the northern regions, many lakes and ponds were gouged out by glaciers during the Ice Ages.
Oxbow Lakes

- Lakes formed by meanders in rivers flowing over floodplains are called **oxbow** lakes
Playa lakes

- **Playa** lakes are small ephemeral lakes common in West Texas and the southern high plains.
Wetlands – the transition zone between water and land

- There are four basic categories of **wetlands**, 
  - marshes
  - swamps
  - bogs
  - fens
Marshes

- **Marshes** are shallow wetlands originating from water runoff and floodwaters and are mainly grassy.
Swamps are areas of wet soils with poor drainage and standing water during times of the year. Swamps are dominated by trees and scrubs.
Bogs are characterized by floating spongy peat deposits. They support carnivorous plants and are acidic.
Fens

- **Fens** are groundwater fed wetlands that are more alkaline than bogs.
Lentic habitat zones

- **Littoral** zone – shallow vegetated zone near the shoreline
- **Limnetic** zone – the top layer of open water areas close enough to the surface for light to penetrate and photosynthesis to occur
- **Profundal** zone – deep bottom water area with little or no light penetration
- **Benthic** zone – the bottom surface of the lake fed only by dead matter that falls from the upper layers
Lake Classification - Some Lakes Have More Nutrients Than Others

- **Oligotrophic lakes** – low levels of nutrients and low primary productivity
Lake Types . . .

- **Mesotrophic lakes** – moderate nutrient levels.
Lake types . . .

- **Eutrophic lakes** – High levels of nutrients and high primary productivity
Lake types . . .

- **Hypereutrophic lakes** – excessive nutrient levels with frequent plankton blooms (pond scum)
The Effect of Nutrient Enrichment on a Lake
Water stratification in lakes

- Large deepwater lakes become layered during summer months
- **Epilimnion** – The warmest zone near the water surface
- **Metalimnion** – The middle layer where temperature declines. The Thermocline is found here, where the temperature changes rapidly
- **Hypolimnion** – The bottom layer that is deep and cold with little change in temperature
Lake stratification layers

Stratification = Layers

Thermal Profile

Depth

0 4

Temperature (°C)

Warmwater "Epilimnion"

Rapid temperature change "Thermocline"

Coldwater "Hypolimnion"
Lakes “turn over” during the year

- When the seasons change, the water in lakes turns over.
- During winter when the surface layer becomes colder than the bottom layers the colder more dense water sinks and the lake “turns over”
- Texas lakes turnover once a year, northern lakes turn over in both spring and fall
Seasonal lake turnover
Aging of lakes

- Lakes and ponds go through a natural aging process called **succession**
- As lakes slowly fill with sediment they become marshes, swamps, or bogs
- As wetland plants move in they build a soil base and eventually the lake becomes dry land