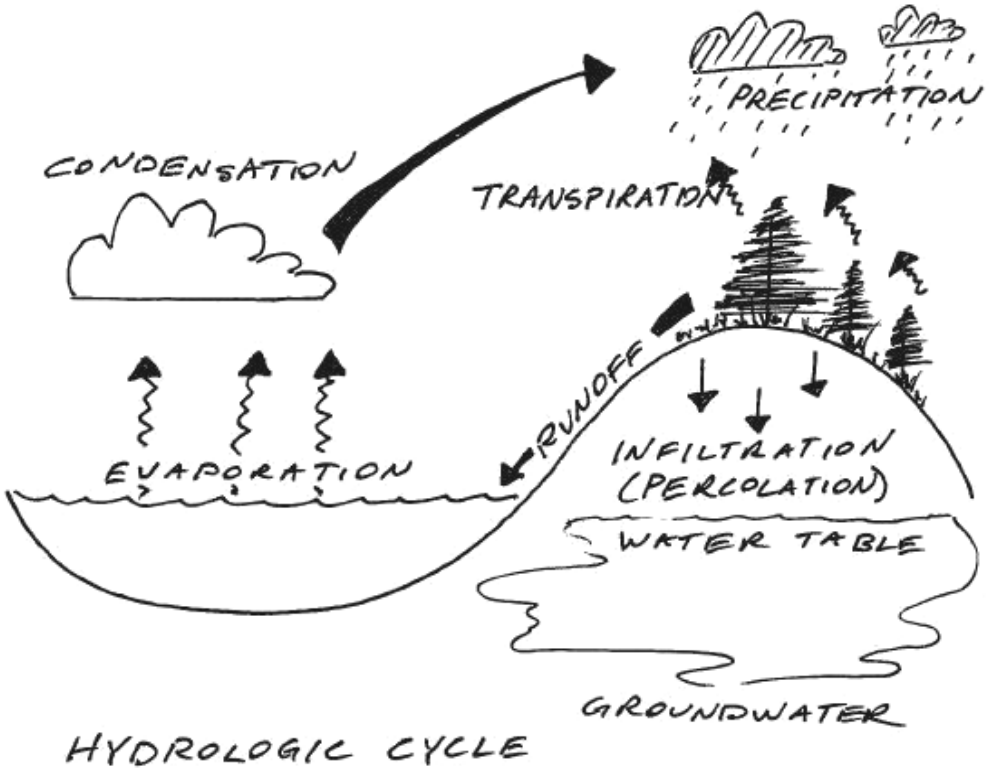
Water Resources

Water is life. The unique characteristics of water support that bold statement. Water molecules are polar. This **polar** nature allows them to cling not only to one another through **cohesion** but also to other molecules through **adhesion**. This also makes water the "universal solvent". Water can also absorb a large amount of heat energy without a significant rise in temperature. This allows it to moderate much of the world's climate. Water covers over seventy percent of Earth's surface. Ninety-seven percent of that is marine or salt water. Glaciers and polar ice account for another two percent. Out of the remaining one percent, less than half is accessible freshwater.

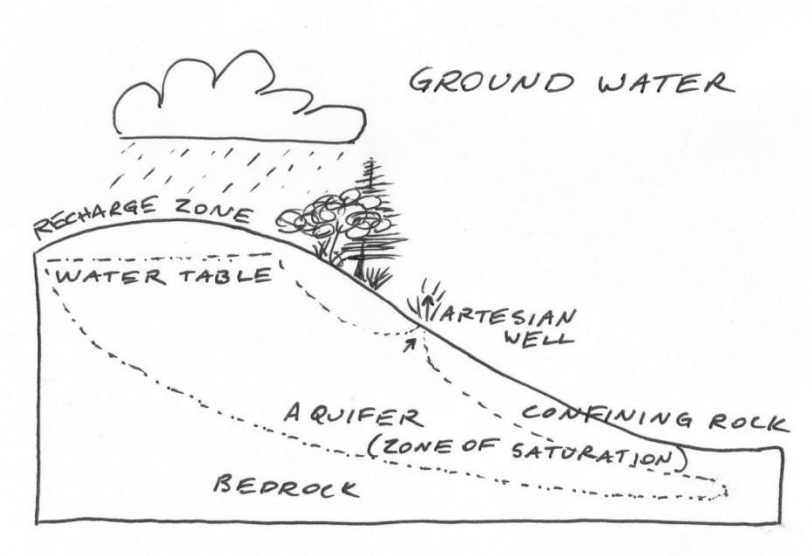
Water is constantly moving through the biosphere through **evaporation, condensation, transpiration** and **precipitation**. These processes are collectively known as the **hydrologic** or **water cycle**. When disturbance is kept to a minimum, the water cycle provides man with a constant renewable resource. However, it has been stretched to its limits with the explosion of the human population, urban and agricultural development in arid environments, and pollution.



HYDROLOGIC CYCLE

In the United States, water is used for irrigation (41%), energy production (38%), industry (11%) and public use (10%). Streams and lakes account for the water found on the surface while the permeable rock layers of aquifers contain the groundwater.

The illustration below points out the key terms associated with aquifers. The largest aquifer in the United States is the Ogallala Aquifer. It lies on the eastern side of the Rocky Mountains and supplies water to eight states. Agriculture and municipalities rely heavily on this aquifer, which has resulted in lower water tables throughout much of its range. It is estimated that in some arid areas of this aquifer the annual recharge is less than fifteen percent of the use. This not only has obvious implications in urban development and agriculture but it also leads to the subsidence of land.



Methods of irrigation can drastically reduce the amount of water being used by agriculture. **Drip systems** are 90-95% efficient while gravity flow systems are only 60-80% efficient.

Surface Water

Surface water can be subdivided into moving water (**lotic ecosystems**) and standing water (**lentic ecosystems**).

Lotic Ecosystems

As a river flows from its source to its end, it undergoes a series of changes. In the beginning, the river is typically swift, cold, and oxygen-rich. The river is narrow and very turbulent. Fauna in this area have to be well adapted to this fast moving water. Primary productivity is generally low in this area. As the river distances itself from its source, it enters into a transition zone. The river broadens and production increases. **Turbidity,** or the measure of suspended solids, increases in this zone. While the river continues to slow, it becomes very shallow and broad as it enters into the next zone, the flood plain. Dissolved oxygen decreases, but the area is rich in biodiversity. Wetlands, both inland and coastal, are associated with this zone. As the river empties into the ocean, an **estuary** is formed. These highly productive, biodiverse ecosystems are critical for both terrestrial and aquatic life forms. Estuaries are nurseries for many species of marine fish and offer critical habitat for many migratory birds.

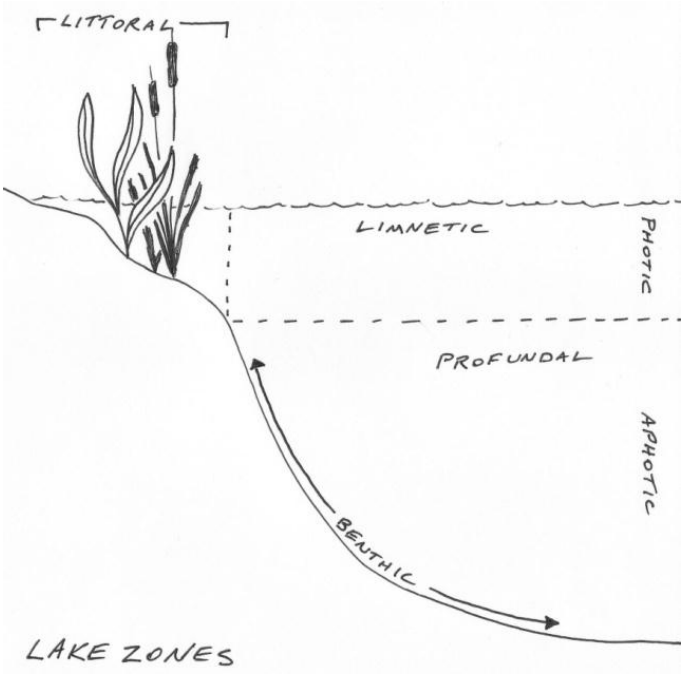
Lentic Ecosystems

Lakes make up the lentic ecosystems. The largest freshwater lake in the United States is Lake Superior while the largest one in the world is Lake Baikal (by volume). The following are the different zones found in lakes.

The **littoral zone** is near the shore. It is shallow enough for roots to gain hold and is highly productive.

The **limnetic zone** (**euphotic**) is the surface of the lake away from shore. Even though it is too deep for rooted plants, there is much production due to phytoplankton and other photosynthetic organisms.

The **profundal zone** is below the limnetic zone and is the area of the lake that does not receive light (**aphotic**). The **benthic zone** is the bottom of the lake. Organisms found here are often dependent on detritus from the limnetic zone.



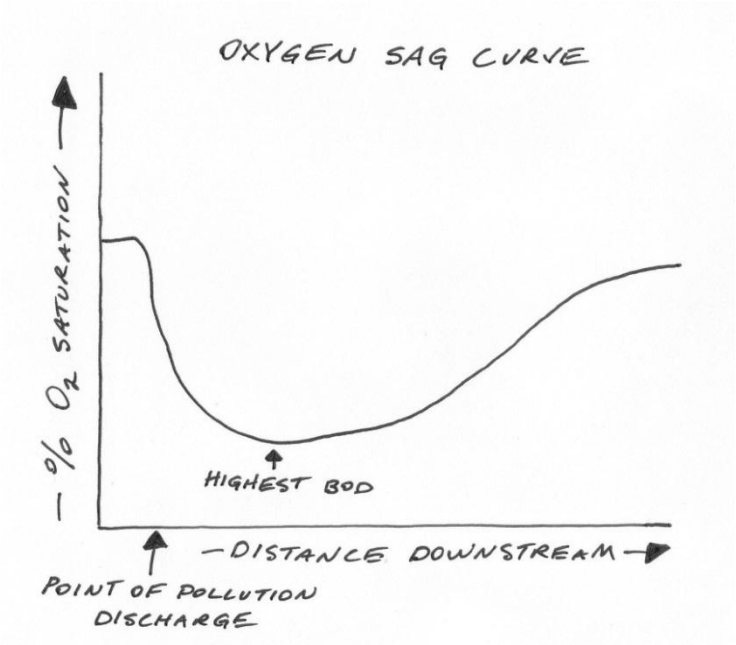
Lakes are often classified by their productivity. **Oligotrophic** lakes are typically young lakes with low productivity. They have clear water, and since they are often associated with colder climates, the dissolved oxygen is typically high. **Eutrophic** lakes are considered mature lakes. Productivity is high and the clarity of water is poor. These lakes are very biodiverse and dissolved oxygen levels are usually lower because of the high demand. **Mesotrophic** lakes fall in between the other two. Although eutrophication is a natural process, man often speeds up the process. When this occurs, it is called **cultural eutrophication**. This is generally a result of a limiting nutrient entering the lake. Typically this is from a nonpoint pollution source like nitrogen fertilizer from agricultural runoff. The increase in the limiting nutrient allows producers to quickly grow and reproduce. **Algal blooms** are often a result. The problem comes when the nutrient is used up and the algae die. Decomposition of the algae reduces dissolved oxygen, which often results in fish die-off.

Lakes are often man-made and these reservoirs provide people with much needed resources. These reservoirs provide water for communities, irrigation, and flood control. They are also a source for recreation. One of the greatest advantages of building these reservoirs is the production of hydroelectric energy. This is a renewable, clean source of electricity. The disadvantages of these projects are loss of biodiversity due to habitat loss, reduction of nutrients deposited downstream, and loss of water through evaporation. The largest reservoir in the United States is Lake Mead created by the Hoover Dam on the Colorado River. Water control

projects on the Colorado River have so greatly affected this river, that the once largest river of the western United States, only trickles into the Pacific Ocean. Three Gorges Dam of China and the James Bay Project of Canada allow those two countries produce the greatest production of hydroelectric energy.

Water Pollution

Pollution, of course, affects both flowing and standing water sources. Pollution can be placed in two general categories: **point source** and **nonpoint source**. Point source pollution is easily identified and can be attributed to one source. An example of this would be a pipe from a factory discharging pollution into a local body of water. Nonpoint pollution comes from a broad area. Examples of nonpoint source pollution are agriculture runoff and storm runoff from urban areas. Water can be polluted by nutrients, organic waste, suspended solids, and excess heat. **Cultural eutrophication**, described earlier, is often a result of excess nutrients. **Biological oxygen demand (BOD)** increases with the presence of organic waste since decomposition, which requires oxygen, leaves less oxygen for the inhabitants of the ecosystem. An **oxygen sag curve** (found on the next page) represents the effect that these oxygen demanding wastes have on a stream. Suspended solids can reduce photosynthesis in a body of water disrupting the flow of energy through the food chain. **Thermal pollution**, often due to the cooling process involved in electricity production by nuclear means, often lowers dissolved oxygen and biodiversity.



Pollution can be monitored by a variety of means. Tests are used to determine the chemical composition of water. These tests include **pH**, **dissolved oxygen**, **nitrates** and **phosphates**. **Secchi disks** are used to measure the effect of solids on the clarity of the water. Biological tests can also be used. The biodiversity of aquatic **macroinvertebrates** is a good indicator for water quality.

The Fine Print

Clean Water Act: The CWA regulates the discharge of pollutants into U.S. waters, and sets water quality levels for contaminants in surface waters.

Safe Drinking Water Act: Protects the quality of bodies of water, above or below ground, that are used for drinking water.

Water Resources Review Questions

Use the following answer choices for questions 1-5

A) Cohesion

B) Transpiration

C) Turbidity

D) Eutrophication

E) Thermal pollution

1. Environmental problem caused by the release of hot water from power plants and industry.

2. The evaporation of water vapor from the leaves of plants.

3. Describes the amount of suspended solids in a water sample.

4. Excess algal growth in a body of water due to excess runoff of fertilizer and animal waste.

5. Property of water that describes the tendency of like molecules to be attracted to each other.

6. Which US environmental law regulates the discharge of pollutants into US bodies of water, and sets water quality levels for contaminants in surface waters.

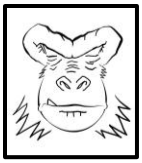
A) Safe Drinking Water Act

B) Lacey Act

C) CITES

D) Montreal Protocol

E) Clean Water Act



APES in a BOX: The Review Sessions

Multiple Choice Scoring Guidelines

1. E	3. C	5. A
2. B	4. D	6. E

Multiple choice points earned/6 * 100 = Quiz average

(_____)/ 6 * 100 = _____ Quiz Grade