Enviro Sci. 20 - Aquatic Ecosystems Background Information

Keywords: ecosystem, ecology, watershed, surface water, hydrologic cycle, evaporation, transpiration, precipitation, surface runoff, percolation, porous, aquifer, groundwater, spring, pond, phytoplankton, zooplankton, photosynthesis

An **ecosystem** is a natural unit of living and nonliving parts that interact to produce a stable system. **Ecology** is the study of ecosystems, or how living things relate to the environment and to one another. Understanding this relationship is important because living things and non-living things depend upon and impact each other.

Ecosystems operate from day to day by exchanging energy. The energy exchanged within an ecosystem is recycled between the physical and biological components. The plants within an ecosystem convert the sun's energy into food, and are in turn grazed upon by animals, which are consumed by predators. Microorganisms within an ecosystem, such as fungi and bacteria, also exchange energy within the ecosystem by breaking down waste material to substances that can be used by plants for food. In this way, each element within the ecosystem depends on the others for survival.

Aquatic Ecosystems

Aquatic ecosystems include oceans, lakes, rivers, streams, creeks, estuaries, ponds and wetlands. Within these aquatic ecosystems are living things that depend on the water for survival, such as fish, plants, and microorganisms. These ecosystems are very fragile and can be easily disturbed by pollution.

Watersheds

All living things within an ecosystem share the same watershed. A **watershed** is an area of land over which water flows to reach a common body of water such as a lake or pond. We all live in a watershed, or drainage basin. Watersheds can be as large as the Mississippi River drainage basin or as small as a farm with a pond. Your watershed may be made up of mountains, farms, houses, businesses, or towns. You share your watershed with all other living things within the ecosystem.

A watershed is a good example of how the living and nonliving things within an ecosystem depend upon each other. Altering a watershed will affect all the living things within that watershed. People can alter a watershed by paving over land and constructing buildings. This will affect how water flows over the land and may cause harmful materials to flow directly into the water. This will have an effect on the organisms that depend on the water for survival. For example, some fish feed on organisms in the water. Polluted water may cause these organisms to die, leaving the fish with no food. This is why we must understand these relationships and protect our water resources.

Describing Aquatic Ecosystems

Ecologists classify aquatic ecosystems according to criteria such as salinity, depth, and whether the water is flowing or standing.

Biomes are described by patterns in temperature and precipitation, but there aren't really hot summers or rainy seasons in the deep ocean. While terrestrial biomes are shaped by air temperature and precipitation, aquatic systems are characterized by factors such as water salinity, depth, and whether the water is moving or standing.

Salinity Salinity measures the amount of salts dissolved in water. A straightforward measurement of salinity is parts per thousand (ppt), meaning the number of units of salt dissolved in 1000 units of water. "Salt water" generally has a salinity between 30 and 50 ppt. The oceans have an average salinity of 35 ppt. Water is considered "fresh" if it has a salinity of a 0.5 ppt or less. The aquatic ecosystems with salinity between 0.5 and 30 ppt are called *brackish*.

The salinity of water has direct effects on an aquatic organism's survival. Adaptations enable organisms to maintain careful water and salt balance with their surroundings. Water moves from areas of high concentration (low salinity) to areas of low concentration (high salinity). As such, a freshwater fish placed in salt water would die from water loss, as water moves from an area of higher concentration (the fish) to an area of lower concentration (the salt water). A saltwater fish moved to fresh water would fare no better. The fish would swell and die as water rushed from an area of higher concentration (the fresh water) to an area of lower concentration (the fish).

Depth In most terrestrial environments, primary production is limited by temperature and precipitation. Under water, however, photosynthesis by aquatic plants and phytoplankton is mostly limited by available light. In aquatic ecosystems, light availability is largely a function of water depth.

▷ *Aquatic Layers* The uppermost layer of an aquatic ecosystem, where there is enough sunlight for photosynthesis, is called the **photic zone.** The depth of the photic zone depends on how clear the water is. In some crystal-clear tropical seas, the photic zone may extend over 200 meters (650 feet), but in muddy streams it could be a meter or less. Below the photic zone is the **aphotic zone,** where no sunlight penetrates and photosynthesis cannot occur. The very bottom of a body of water is called the **benthic zone.** Depending on the depth and clarity of the water, benthic zones can be sunlit or pitch dark.

▷ *Depth and Life* Consumers on land rely on oxygen in the air to breathe. Some aquatic consumers, such as sea turtles and whales, breathe in air by periodically rising to the top of the water. Most aquatic consumers, however, do not breathe air. Instead, they obtain the oxygen they need to carry out cellular respiration from water taken in through gills. Dissolved oxygen in the water comes from aquatic photosynthetic organisms that release oxygen during photosynthesis. The photic zone, where photosynthesis can take place, has much more dissolved oxygen than the aphotic zone. Therefore, there tends to be more life—both producers and consumers—in this upper portion of any aquatic ecosystem.

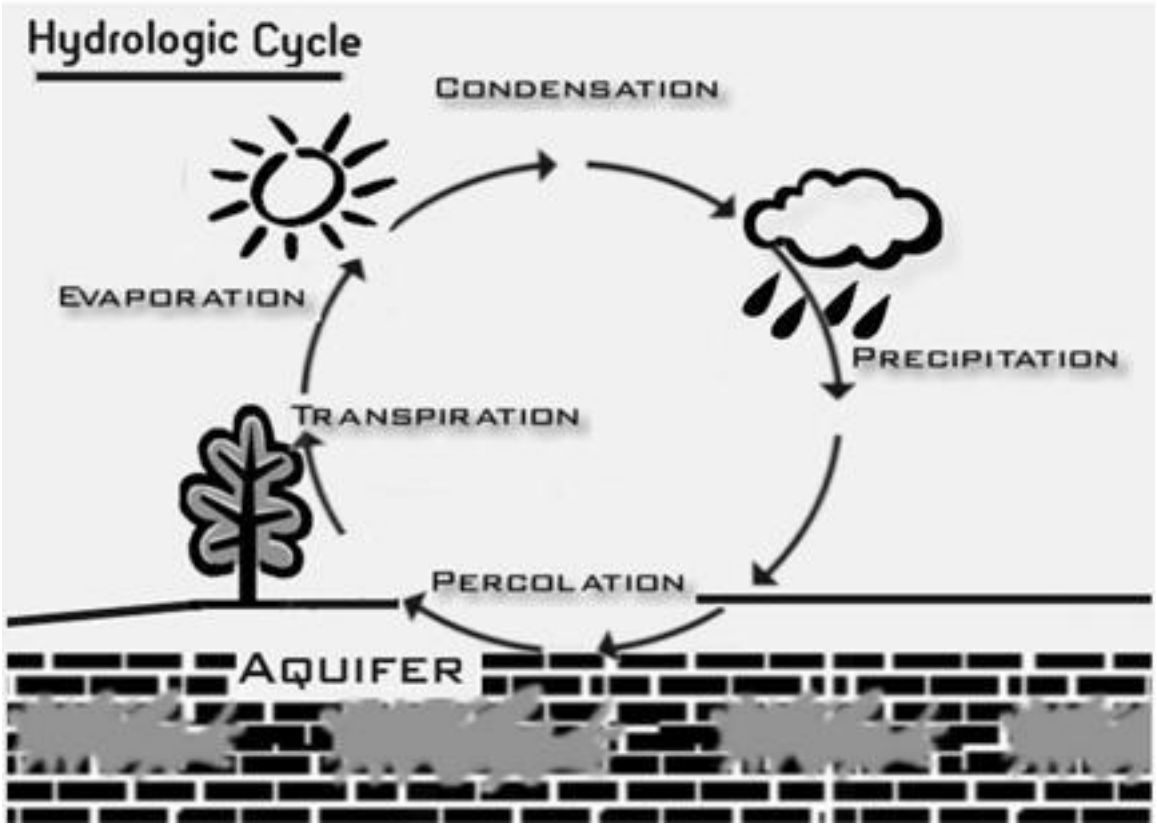
▷ *Depth and Temperature* The presence of sunlight also causes warmer temperatures. Upper layers of aquatic ecosystems tend to be warmer than deeper layers. Temperature shifts can occur, however, brought on by seasonal temperature changes or shifting currents.

Flowing and Standing Water Aquatic ecosystems are sometimes divided into flowing-water and standing-water categories. Flowing-water ecosystems contain water that is in near-constant motion, such as in a river. Standing-water ecosystems contain water that does not move, or moves slowly, such as in a pond or wetland.

Today's Water

Only 1 percent of the water on Earth is available to humans as fresh water. Most of the earth's water exists in the oceans as salt water. The small percentage of water remaining on the earth's surface is found trapped in polar ice caps and glaciers, within the ground as fresh groundwater, fresh surface water, and in the atmosphere. Fresh **surface water** includes water in lakes, rivers, streams, creeks, ponds, and wetlands. Humans obtain their fresh water from surface waters and groundwater. These make up only a small quantity of the world's water. This is why we must protect our fresh water supplies.

The Hydrologic Cycle



The **hydrologic cycle** is the circulation of water among the oceans, the atmosphere, and the land masses, through evaporation, precipitation, surface runoff, and groundwater percolation. The cycle has no beginning and no end. This means there is no new water put into the cycle, the same water is used over and over again. Water exists in all stages of the cycle: oceans, clouds, lakes and rivers, and below the surface as ground water. The water may exist as each of the three states of matter: solid, liquid, or gas. **Evaporation** is the change in water from a liquid to a gas. Water evaporates from the surface of the oceans, lakes, streams, and rivers. As the sun heats the surface waters, water will be released into the atmosphere in the form of water vapor. The greater the sun's energy, the more evaporation occurs. The

sun can also cause water to evaporate from plants leaves through a process called **transpiration**.
Water vapor rises from the surface waters and enters the atmosphere where it is transported by winds. When atmospheric conditions are suitable, water droplets will form and stick together to form clouds. This process is called **condensation**. When the atmosphere is saturated, or cannot hold anymore water vapor, these droplets will be released and fall to the earth's surface as precipitation.

Precipitation is water that is released from the atmosphere as rain, snow, hail, etc. Precipitation that falls to the Earth's surface can enter several different pathways within the hydrologic cycle. Precipitation that falls over bodies of water such as lakes and rivers becomes surface water, Precipitation that drains across the land and into lakes, streams, and rivers is termed **surface runoff**,

Plants and animals will use some of the precipitation that falls over land, and some of the precipitation will be absorbed by the ground and moves downward through the soil in a process called **percolation**. Once the surface water has moved underground it is called **groundwater**.

The water that enters these pathways eventually finds its way back to the oceans through river runoff, groundwater flow, and melting ice, which all discharge water into the oceans. This closes the hydrologic cycle by returning the water originally removed from the ocean by evaporation.

In this way, water goes around the hydrologic cycle. No new water is put on Earth; it is just stored in different places on Earth in different states (solid, liquid, and gas). This means that we have the same amount of water on earth today as when the dinosaurs roamed the planet.

How Does Water Get Underground?

Water that falls to the earth's surface will runoff the land to join a body of water, be absorbed by the soil and move downward through the ground or be evaporated. Water that seeps into the soil will percolate through the ground and become part of the underground water system. This is how surface water gets underground. Groundwater moves underground through the tiny spaces between rocks.

Groundwater is important because most of the population depends on underground water for drinking water. Groundwater can become polluted through percolation of contaminated surface waters. The water on the surface will pick up any contaminates on the ground and transport these through the soil into the groundwater

Underground Water and Aquifers

Below the ground is a series of rocks that act as a sponge for groundwater, soaking up water and holding it in many crevices and grooves. The spaces in a rock where the water will move are called pores. A rock that has many pores is called a **porous** rock. An underground water system that is made of very porous rock and sand material is called an **aquifer**. An aquifer holds and allows groundwater to flow through the spaces between the rocks. The rocks help filter the groundwater by absorbing some pollutants that may be found in the water.

Your local aquifer holds fresh groundwater beneath the surface. In some areas the aquifer will be deep within the ground and covered by a thick layer of rock that is not as porous as the rock of the aquifer below. In other areas the aquifer is not far beneath the surface and water can easily seep into the ground and enter the aquifer. This type of aquifer also allows harmful pollutants on the surface to easily enter the aquifer and contaminate the groundwater.

How Does Underground Water Get to the Surface?

Groundwater can also re-emerge at the surface. Underground water can sometimes flow into a surface water body such as a lake, stream, or pond. For example, a **spring** is water that is returning to the surface after being absorbed by the ground.

Springs can discharge freshwater into large surface water bodies such as lakes and streams, and even offshore in the oceans. Springs connect the groundwater to the surface water.

Pond Cycles

Ponds play an important role in aquatic ecosystems. Ponds can develop naturally in a low-lying area and produce a surrounding ecosystem that is unique. Wildlife depends upon ponds for food, shelter, and breeding. Ponds can provide much needed water for birds and wildlife.

Ponds are important to the watershed connection. They capture rainwater as it flows over the ground, reducing erosion and flooding. By holding stormwater, ponds allow nutrients and other chemicals to be filtered from the water by plants and animals before it moves into rivers and lakes. Therefore, ponds can

help protect the watershed from harmful pollutants.

Ponds are a good example of an ecosystem in which all elements work together to maintain a balance between physical and biological processes. The plants and animals of a pond work together for survival. Water is essential to the pond ecosystem. The quality of the water can determine the type of aquatic animals found and the health of the ecosystem.

The Role of Aquatic Plants

Plant life that grows in and around a pond ranges from single celled algae, called **phytoplankton**, to large woody trees. Plants are vital to the functioning of ponds. Plants that grow along the edge of a pond help reduce erosion, capture pollutants before they can enter the water, stabilize sediments, and take up excess nutrients.

Plant life converts energy from the sun into food through **photosynthesis**. By converting the sun's energy and water's nutrients into carbon-based energy, plants form the base of the food chain in ponds. Tiny animals in the water, called **zooplankton**, use phytoplankton as a food source. Larger animals such as fish, use zooplankton as a food source. And still larger animals, such as birds, feed on fish. Birds and small mammals make up a higher level of the food chain in a pond.

Larger aquatic plants can grow rooted to the bottom of ponds and are supported by the water. These plants help stabilize the sediments on the bottom of the pond. They also provide food and living space for animals that live on the bottom, such as snails. Rooted plants also help keep the pond water clear and free of algae because they take up nutrients, which would otherwise be available to algae.

Plants can also affect the bird life that is found near a pond. Birds use large aquatic plants for nesting, resting, and refuge. Large plants are also used for food.

Wildlife

The wildlife present in a pond can range from amphibians to migrating birds. Common wildlife species that are found near ponds include: raccoons, birds, turtles, snakes, frogs, and salamanders.

Aquatic animals help recycle the nutrients within the pond ecosystem. By feeding on plants, seeds, fruits, and tubers they take up nutrients from the water and recycle them when they decay. Animals can also

remove nutrients from the pond by feeding on plants and moving out of the pond, either to the surrounding area or another ecosystem.

Animals of the pond are important seed dispersers. Many animals will disperse seeds around the pond ecosystem and thereby help maintain the population and diversity of plants. Animals can also disperse seeds to other areas. A migratory bird that injests a seed can transport it and deposit the seed in a new area, creating a new habitat.

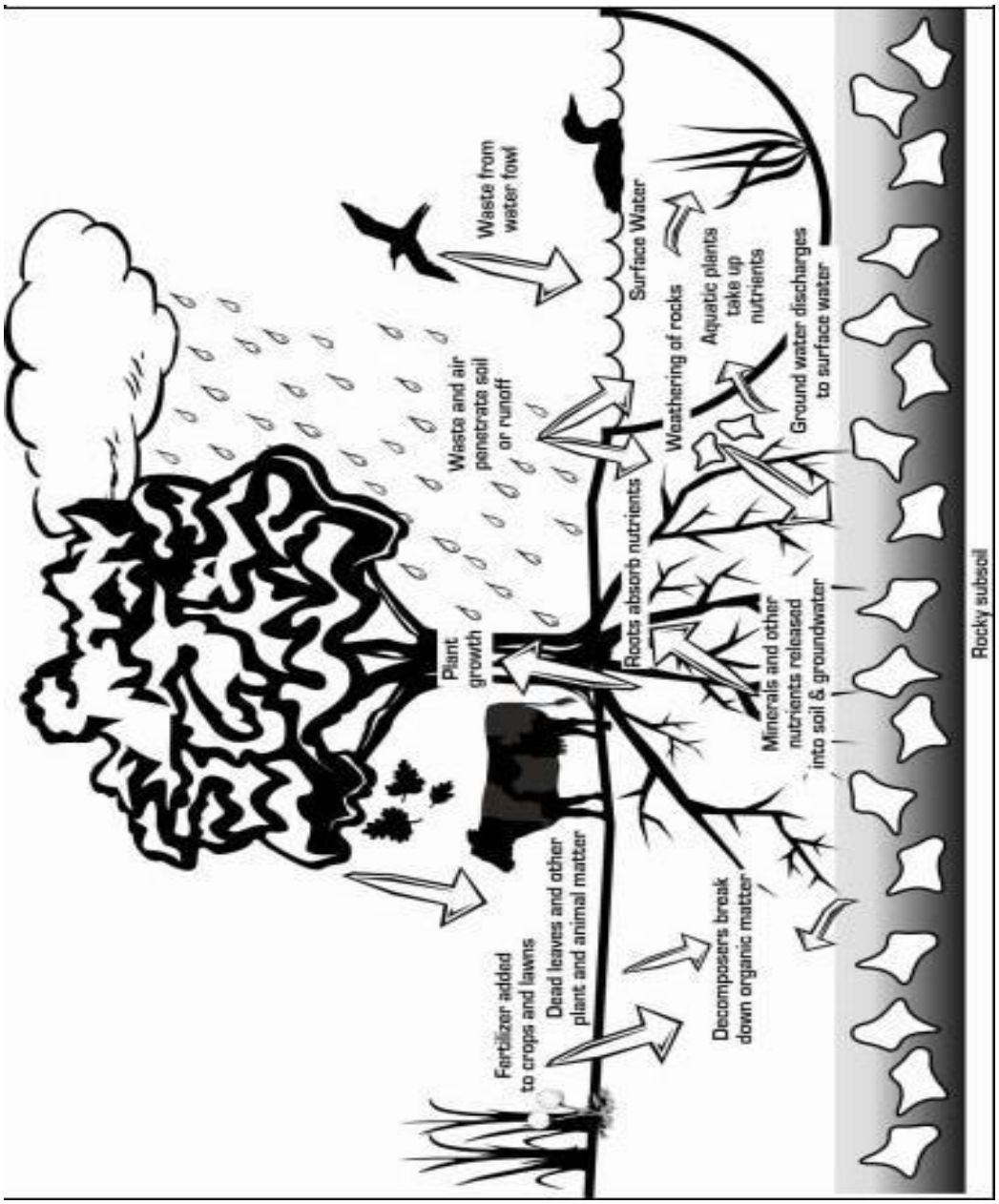
Most of the wildlife spend the majority of their lives in the areas surrounding the pond. Therefore, the type of land present around the pond is important. For example, female turtles must dig holes in the surrounding banks and lay their eggs. The pond edge is important habitat for insects, frogs, small fish, and wading birds.

The Pond Watershed

Ponds are important to the overall health of the watershed because they collect stormwater before it enters larger water bodies. Stormwater draining from the nearby land can contain many unwanted chemicals that can be taken up by plants and animals and redistributed within the ecosystem. Ponds often drain into larger bodies of water such as lakes and streams. Therefore, it is important to maintain the health of the pond.

The type of land surrounding a pond is important to maintaining the health of the pond. If the surrounding land is used for agricultural purposes then chemicals used on the land may contaminate the water of the pond, raising the nutrient levels. A pond can become harmful to fish and wildlife when unnaturally high nutrient levels are present.

The best way to maintain a healthy pond ecosystem and surrounding watershed is to prevent water pollution by picking up any debris that could be washed into the pond, using fertilizers sparingly on your lawn, and learning about the native aquatic life of your local pond.



Water Facts:

- There are about one million miles of pipeline and aqueducts for water delivery in the US and Canada...enough to go around the earth 40 times!
- Water is the most common substance on earth, however only 1% of the earth's water is available for drinking.
- 66% (two-thirds) of the human body is water. A cow must drink 3 gallons of water to make 1 gallon of milk.
- 75% of a tree is water. 70% of an elephant is water.
- You can survive about three weeks without food, but only 3 days without water.
- It takes 50 glasses of water to grow enough oranges to make 1 glass of orange juice.

- You can fill an 8 oz. glass of water about 15, 000 times for the same cost as a six pack of soda pop.
- Rivers and streams make up 3.5 million miles.Lakes cover 41 million acres
- The average daily requirement for freshwater in the United States is about 338 billion gallons.
- There are more than 200,000 individual water systems providing water to the public in the United States.
- If the Earth were completely flat, it would be covered by water 2 miles deep.
- One gallon of gasoline can contaminate 750,000 gallons of water.
- We use about 108 gallons of water per person per day in our homes. There's as much water in the world today as there was thousands of years ago. In fact, it's the same water.
- A single dripping faucet can waste far more in a single day than one person needs for drinking in an entire week.
- Every glass of water brought to your table in a restaurant requires another two glasses to wash and rinse the glass.
- A leak of one drop per second wastes 2,400 gallons of water per year.

Questions - Check For Understanding:

1. Define what an ecosystem is and describe the role they play in our world.
2. What factors are used to classify and describe Aquatic Ecosystems?
3. What is a watershed, why are they important, and how can human altercation to a watershed affect an ecosystem?
4. In your own words explain the hydrological (water) cycle. Draw a detail diagram of the water cycle from memory and then look back and make any corrections needed.
5. Define: evaporation, transpiration, precipitation, percolation, and condensation
6. In your own words explain how water gets underground.
7. Explain what an aquifer is?
8. In your own words explain how water can get above ground?
9. Explain why wildlife adds to a healthy aquatic ecosystem?
10. Explain the importance of ponds and how a pond can help keep a watershed healthy? Refer to the diagram on the previous page.
11. What are the role of aquatic plants in a watershed?
12. List 3 water facts that you didn't know before you read this and explain why each one you picked is important to know about.