# Lesson 1: Aquatic Ecosystems

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 and Watersheds

Aquatic ecosystems include oceans, lakes, rivers, streams, estuaries, 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.

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.

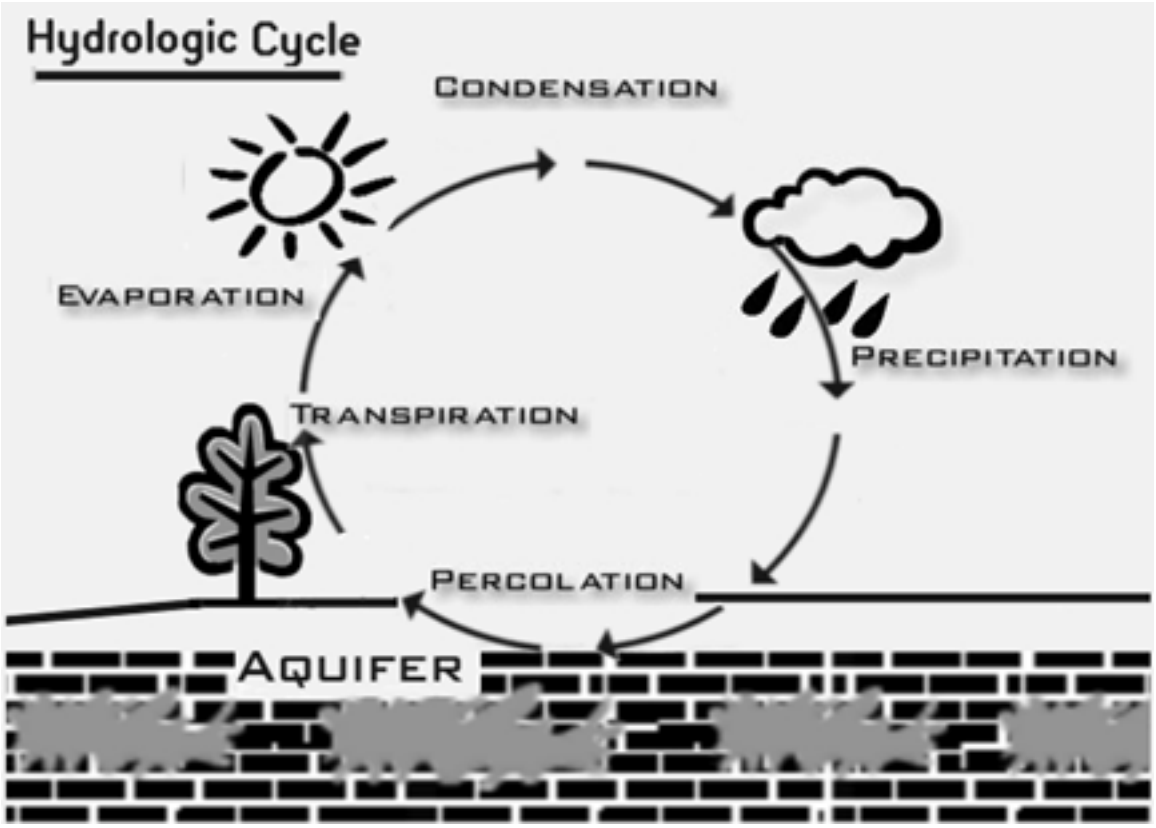
A watershed is a good example of how the living and nonliving things within an ecosystem depend upon each other. Altering a watershed will affect all the living things within that watershed. People can alter a watershed by paving over land and constructing buildings. This will affect how water flows 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.

## 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 an 8d 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.

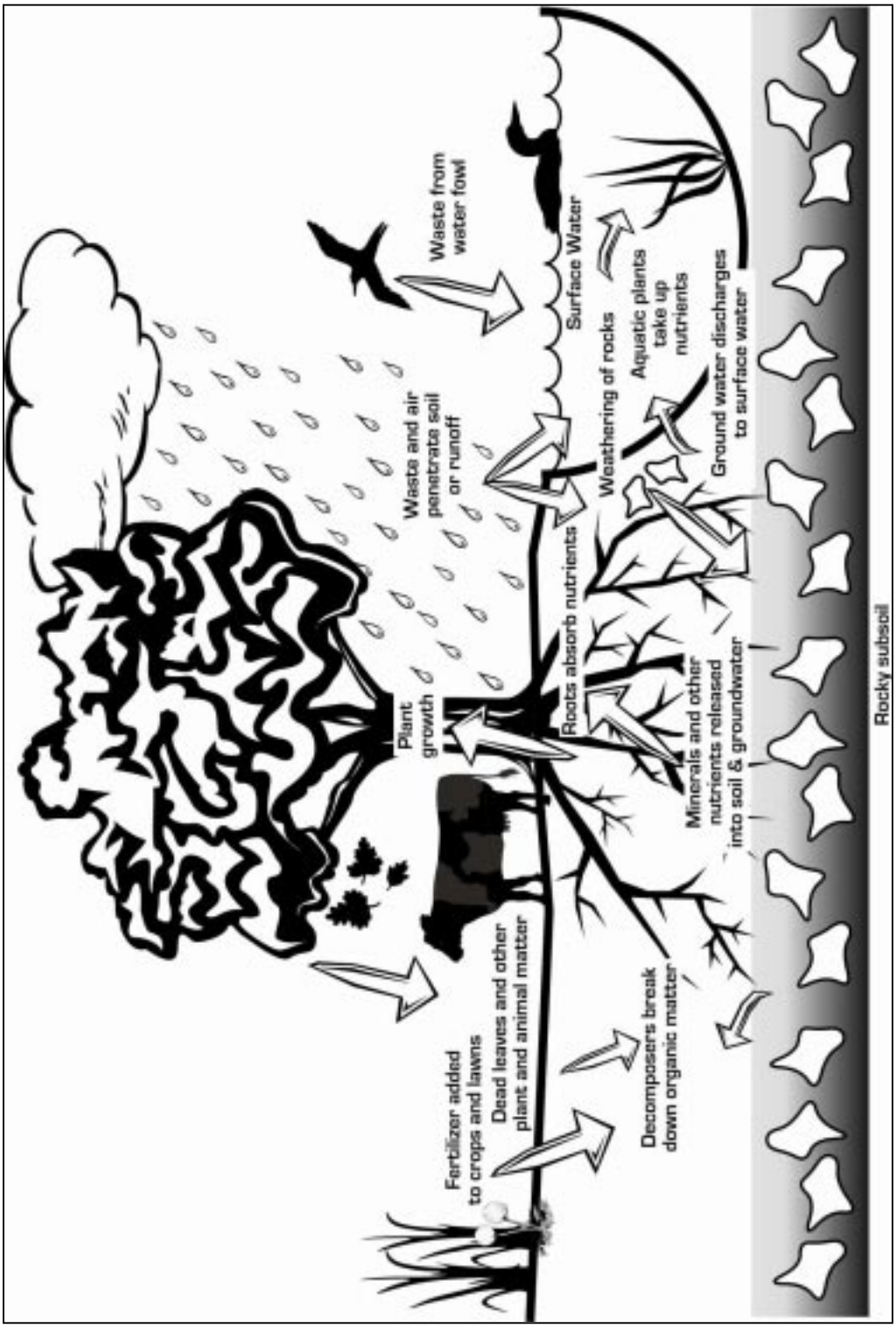
Most of the wildlife spend the majority of their lives in the areas surrounding the pond. Therefore, the type of land present around the pond is important. For example, female turtles must dig holes in the surrounding banks and lay their eggs. The pond edge is important habitat for insects, frogs, small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


Waste from water fowl
Surface Water
Aquatic plants take up nutrients
Weathering of rocks
Ground water discharges to surface water
Waste and air penetrate soil or runoff
Roots absorb nutrients
Plant growth
Minerals and other nutrients released into soil & groundwater
Rocky subsoil
Fertilizer added to crops and lawns
Dead leaves and other plant and animal matter
Decomposers break down organic matter

## 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.

If you find any interesting facts, or have any questions that you would like to share with the staff at Project Oceanography, please feel free to call us at: 1-800-51-OCEAN or e-mail us at: pjocean@marine.usf.edu We will answer you either via e-mail or on the air during a broadcast. Visit our website at http://www.marine.usf.edu/pjocean/index.html

# Activity 1-1. Create Your Own Watershed

**Objective**

To teach the function of watersheds
To stimulate thought about the role watersheds play in the world

**Materials needed**

- Large aluminum cake pan
- Several pieces of crumpled paper
- Large sheet of aluminum foil or plastic wrap
- Variety of colored powders (cocoa, fruit drinks, etc.)
- Clear Water
- Spray Bottle
- Small model pieces to represent homes, trees, cars, farm animals, etc.

**Activity**

1. To set up the activity, crumple several pieces of newspaper or other paper.
2. Place paper in cake pan to represent different elevation levels of land. Cover the paper with aluminum foil or plastic wrap. Position small model pieces as desired.
3. Use a spray bottle to spray clear water at the highest elevation. Observe results.
4. Add small amounts of colored powders to various places to represent soil erosion, green fruit drink mix powder may represent fertilizer, etc.
5. Again, use the spray bottle to spray water at the highest elevation. Observe results.

**Discussion Questions**

1. What happened the first time you sprayed clear water on your watershed model?
2. What happened to the pollutants when you sprayed water again?
3. What could be done to reduce the amount of pollutants affecting your watershed?
4. How does your watershed compare with watershed models made by other
5. classmates?

# Activity 1-2. Edible Groundwater Model

*Source: The Groundwater Foundation Kids Corner. http://www.groundwater.org/KidsCorner/activity.htm*

**Objective**

To teach about the geologic formations in an aquifer
To demonstrate how pollutants enter the groundwater system
To illustrate the effects of pumping on the groundwater system

**Materials needed:**

- Blue or red food coloring
- Vanilla ice cream
- Clear soda
- Crushed ice
- Cake decoration sprinkles
- Drinking straws
- Clear plastic cups or bowls

**Activity**

1. Fill a clear plastic cup or bowl 1/3 full with crushed ice to represent gravel and soil.
2. Add enough soda to just cover the ice.
3. Add a layer of ice cream to serve as a confining layer over the water-filled aquifer.
4. Then add more crushed ice on top of the confining layer. Colored sprinkles represent soils and should be sprinkled over the top to create the porous top layer.
5. Now add food coloring to the soda. The food coloring represents contamination.
6. Watch what happens when it is poured on top of the'aquifer'.
7. Using your straw, drill a well into the center of your aquifer.
8. Slowly begin to pump the well by sucking on the straw. Watch the decline of the water level. Notice how the contaminants can get sucked into the well area and end up in the groundwater by leaking through the confining layer.
9. Now recharge your aquifer by pouring more soda over the top. This represents rain falling.

# STUDENT INFORMATION SHEET LESSON 1.
# Aquatic Ecosystems

Water is important to all living things. Not only do people need water, but plants, animals and other living things need it too. Did you know that two-thirds of your body is water? And almost every living thing depends on water for more than half of its body weight.

For example,
a living tree is 75% water,
an elephant is 70% water,
a tomato is 95% water,
an ear of corn is 80% water.

All living things are connected through the need for clean, fresh water. That is why it is so important to use our water carefully and protect it from pollution.

In order to know how to protect our water, we must first understand where it comes from. As water travels through the environment it changes. It can become part of an ocean or a pond. It can be absorbed by the soil for plants to use. It can travel through your own county's water system and right out the end of your faucet. These paths that water takes as it travels through the environment make up the water cycle.

Water traveling through your neighborhood may fall from clouds and run over streets and lawns into a nearby lake, stream, or pond. The land that water flows over before it reaches a body of water is called a **watershed**. Everyone lives in a watershed. Your watershed may be made up of mountains, farms, houses, or businesses.