RESOURCE

ENCYCLOPEDIC ENTRY

Lake

A lake is a body of water that is surrounded by land. There are millions of lakes in the world.

GRADES

7 - 12+

SUBJECTS

Biology, Ecology, Earth Science, Experiential Learning, Geography, Physical Geography

1/24

PHOTOGRAPH

Bella, Swans

A family of swans navigate the waters of Belmont Lake, New York. Lakes are bodies of freshwater entirely surrounded by land. There are lakes on every continent and in every ecosystem.

PHOTOGRAPH BY DIANE CHATTERTON, MYSHOT

ARTICLE VOCABULARY

A lake is a body of water that is surrounded by land. There are millions of lakes in the world. They are found on every continent and in every kind of environment—in mountains and deserts, on plains, and near seashores.

Lakes vary greatly in size. Some measure only a few square meters and are small enough to fit in your backyard. Such small lakes are often referred to as ponds. Other lakes are so big that they are called seas. The Caspian Sea, in Europe and Asia, is the world's largest lake, with an area of more than 370,000 square kilometers (143,000 square miles).

Lakes also vary greatly in depth. The world's deepest lake is Lake Baikal, in Russia. Its bottom is nearly 2 kilometers (more than 1 mile) below the surface in places. Although Lake Baikal covers less than half the surface area of Lake Superior—one of North America's Great Lakes—it is about four times deeper and holds nearly as much water as all five of the Great Lakes combined. Other lakes are so shallow that a person could easily wade across them.

Lakes exist at many different elevations. One of the highest is Lake Titicaca, in the Andes Mountains between Bolivia and Peru. It is about 3,810 meters (12,500 feet) above sea level. The lowest lake is the Dead Sea, between Israel and Jordan. It is more than 395 meters (1,300 feet) below sea level.

The water in lakes comes from rain, snow, melting ice, streams, and groundwater seepage. Most lakes contain freshwater.

All lakes are either open or closed. If water leaves a lake by a river or other outlet, it is said to be open. All freshwater lakes are open. If water only leaves a lake by evaporation, the lake is closed. Closed lakes usually become saline, or salty. This is because as the water evaporates, it leaves behind solids—mostly salts. The Great Salt Lake, in the U.S. state of Utah, is the largest saline lake in North America. Its water is saltier than the ocean. Surrounding the Great Salt Lake are salt flats, areas where the lake has evaporated, leaving only stretches of white salt.

How Lakes Are Formed

All lakes fill bowl-shaped depressions in the Earth's surface, called basins. Lake basins are formed in several ways.

Many lakes, especially those in the Northern Hemisphere, were formed by glaciers that covered large areas of land during the most recent ice age, about 18,000 years ago.

The huge masses of ice carved out great pits and scrubbed the land as they moved slowly along. When the glaciers melted, water filled those depressions, forming lakes. Glaciers also carved deep valleys and deposited large quantities of earth, pebbles, and boulders as they melted. These materials sometimes formed dams that trapped water and created more lakes.

Many areas of North America and Europe are dotted with glacial lakes. The U.S. state of Minnesota is nicknamed "The Land of 10,000 Lakes" because of the number of glacial lakes. Many lakes in North America, including the Great Lakes, were created primarily by glaciers.

Some lake basins form where plate tectonics changed the Earth's crust, making it buckle and fold or break apart. When the crust breaks, deep cracks, called faults, may form. These faults make natural basins that may fill with water from rainfall or from streams flowing in the basin. When these movements occur near the ocean, part of the ocean may be trapped by a new block of land thrust up from below the Earth's surface. The Caspian Sea was formed this way. Lake Baikal was also formed by the movement of tectonic plates.

Many lakes form as a result of volcanoes. After a volcano becomes inactive, its crater may fill with rain or melted snow. Sometimes the top of a volcano is blown off or collapses during an eruption, leaving a depression called a caldera. It, too, may fill with rainwater and become a lake. Crater Lake, in the U.S. state of Oregon, one of the deepest lakes in the world, was created when ancient Mount Mazama's volcanic cone collapsed.

Not all lakes are created by basins filling with water. Some lakes are formed by rivers. Mature rivers often wind back and forth across a plain in wide loops called meanders. During periods of flooding, a swollen, rushing river

may create a shortcut and bypass a meander, leaving a body of standing water. This type of small lake is called an oxbow lake, because its shape resembles the U-shaped frame that fits over an ox's neck when it is harnessed to pull a wagon or a plow.

Lakes may also be created by landslides or mudslides that send soil, rock, or mud sliding down hills and mountains. The debris piles up in natural dams that can block the flow of a stream, forming a lake.

Dams that beavers build out of tree branches can plug up rivers or streams and make large ponds or marshes.

People make lakes by digging basins or by damming rivers or springs. These artificial lakes can become reservoirs, storing water for irrigation, hygiene, and industrial use. Artificial lakes also provide recreational use for boating, swimming, or fishing.

Artificial lakes can provide electricity through hydroelectric power plants at the dam. Lake Mead, in the U.S. states of Arizona and Nevada, was formed when the Hoover Dam was built during the Great Depression. The dam was built to control the unpredictable Colorado River and provides electricity to the western United States.

Chemical and Physical Aspects of Lakes

Temperature, light, and wind are three of the main factors that affect the physical characteristics of a lake. Temperature and light vary from lake to lake. Depth, plant growth, dissolved materials, time of day, season, and latitude can all affect light's ability to pass through the lake's water.

Light and wind affect the temperature in lakes. Sunlight warms the water, and wind cools it down. Most lakes go through a process called thermal stratification. Thermal stratification refers to a lake's three main layers, each with a different temperature range. A lake's shallowest layer is the epilimnion. Its middle layer is the metalimnion, or thermocline. The deepest layer is the hypolimnion.

The most important chemicals in a lake are nitrogen and phosphorus. These

chemicals allow nutrient-rich plants and algae to grow. Other organisms feed off these plants and algae, creating a complex, healthy ecosystem.

The chemistry of a lake is affected by biological, geological, and human processes. The balance of nutrients may be altered by biological phenomena such as "algal blooms," when algae reproduces so rapidly it prevents any nutrients from reaching below the lake's surface. Natural processes such as the eruption of a nearby volcano can alter the chemical aspect of a lake by introducing new gases or minerals. Pollution, such as the introduction of toxic chemicals from industry or agriculture, can also affect a lake's chemistry.

The amount of oxygen and the pH level can also affect a lake's chemistry. A lake must have a healthy amount of oxygen to sustain life. Lakes that do not have enough oxygen to sustain life are abiotic.

The pH level is a chemical property of all substances. A substance's pH level indicates whether it is an acid or a base. Substances with a pH of less than 7 are acidic; substances with a pH greater than 7 are basic. Lakes have different pH levels, with life adapting to different chemical environments. Lake Tanganyika, one of the African Great Lakes, has an extremely high pH. It is full of dissolved minerals. Fish such as cichlids thrive in Lake Tanganyika. Tilapia, a variety of cichlid, can also thrive in lakes with very low pH.

The Life Cycle of Lakes

Once formed, lakes do not stay the same. Like people, they go through different life stages—youth, maturity, old age, and death. All lakes, even the largest, slowly disappear as their basins fill with sediment and plant material. The natural aging of a lake happens very slowly, over the course of hundreds and even thousands of years. But with human influence, it can take only decades.

A lake's plants and algae slowly die. The warm, shallow water of the upper layer of the lake causes plants and algae to decompose, and eventually they sink to the basin. Dust and mineral deposits on the bottom of the lake combine with the plants to form sediment. Rain washes soil and pebbles into the basin. The remains of fish and other animals pile up on the lake's

bottom. The lake becomes smaller, starting at the edges and working toward the middle. Eventually, the lake becomes a marsh, bog, or swamp. At this point, the drying-up process slows down dramatically; limnologists, people who study lakes and ponds, aren't sure why. Eventually, the lake becomes dry land.

Dry lake beds are a perfect place to find and study fossils. Archaeologists often excavate ancient lake beds, such as Fossil Butte in the U.S. state of Wyoming. The remains of organisms, from single-celled bacteria to dinosaurs, were preserved over time as sediment on the lake bed built up around and on top of them. In fact, some scientists believe the first living organisms on Earth developed in lakes.

Lake Classification

There are three basic ways that limnologists classify lakes: how many nutrients lakes have, how their water mixes, and what kinds of fish live in them.

When lakes are classified by the amount of nutrients they have, limnologists are using the trophic system. Generally, the clearer the water in the lake, the fewer nutrients it has. Lakes that are very nutrient-rich are cloudy and hard to see through; this includes lakes that are unhealthy because they have too many nutrients. Lakes need to have a balance of nutrients.

Lakes can also be classified by how the water mixes, or turns over from top (epilimnion) to bottom (hypolimnion). This is called lake turnover. Water in some lakes, mostly shallow ones, mixes all year long. These lakes have very little lake turnover.

Deep lakes experience lake turnover on a large scale. The middle layer, the thermocline, mixes and turns over throughout the year. It turns over due to climate, nutrient variations, and geologic activity such as earthquakes. However, major lake turnover happens during the fall and spring, when the lake's cold and warm waters mix and readjust. Most lakes that experience lake turnover are dimictic lakes, meaning their waters mix twice a year, usually in fall and spring.

Lake turnover changes with the seasons. During the summer, the epilimnion, or surface layer, is the warmest. It is heated by the sun. The deepest layer, the hypolimnion, is the coldest. The sun's radiation does not reach this cold, dark layer.

During the fall, the warm surface water begins to cool. As water cools, it becomes more dense, causing it to sink. This cold, dense water sinks to the bottom of the lake. It forces the water of the hypolimnion to rise.

During the winter, the epilimnion is coldest because it is exposed to wind, snow, and low air temperatures. The hypolimnion is the warmest. It is insulated by the earth. This is why there is ice on lakes during the winter, while fish swim in slightly warmer, liquid water beneath.

During the spring, the lake turns over again. The cold surface water sinks to the bottom, forcing the warmer, less dense water upward.

The final way to classify lakes is by the kinds of fish they have. This helps people in the fishing industry identify what kinds of fish they might be able to catch in that lake. For example, calling a lake a cold-water lake tells a fisherman that he can probably expect to find trout, a cold-water fish. A lake that has thick, muddy sediment is more likely to have catfish.

There are other ways of classifying a lake, such as by whether it is closed or fed by a river or stream. States also divide lakes into ones that are available for public use and ones that are not. Many people refer to lakes by size.

How Animals and Plants Use Lakes

Lakes are important in preserving wildlife. They serve as migration stops and breeding grounds for many birds and as refuges for a wide variety of other animals. They provide homes for a diversity of organisms, from microscopic plants and animals to fish that may weigh hundreds of kilograms. The largest fish found in lakes is the sturgeon, which can grow to 6 meters (20 feet) and weigh more than 680 kilograms (1,500 pounds).

Plants growing along the lakeshore may include mosses, ferns, reeds, rushes, and cattails. Small animals such as snails, shrimp, crayfish, worms, frogs, and dragonflies live among the plants and lay their eggs on them

both above and below the waterline. Farther from the shore, floating plants such as water lilies and water hyacinths often thrive. They have air-filled bladders, or sacs, that help keep them afloat. These plants shelter small fish that dart in and out under their leaves. Waterbugs, beetles, and spiders glide and skitter across the surface or just below it. Small islands, floating plants, or fallen logs provide sunny spots for turtles to warm themselves.

Other animals live near the lake, such as bats and semi-aquatic animals, such as mink, salamanders, beavers, and turtles. Semi-aquatic animals need both water and land to survive, so both the lake and the shore are important to them.

Many kinds of water birds live on lakes or gather there to breed and raise their young. Ducks are the most common lake birds. Others include swans, geese, loons, kingfishers, herons, and bald eagles.

Many people think of fish when they think of lakes. Some of the most common fish found in lakes are tiny shiners, sunfish, perch, bass, crappie, muskie, walleye, perch, lake trout, pike, eels, catfish, salmon, and sturgeon. Many of these provide food for people.

How People Use Lakes

Lakes are an important part of the water cycle; they are where all the water in an area collects. Water filters down through the watershed, which is all the streams and rivers that flow into a specific lake.

Lakes are valuable resources for people in a variety of ways. Through the centuries, lakes have provided routes for travel and trade. The Great Lakes of North America, for example, are major inland routes for ships carrying grain and raw materials such as iron ore and coal.

Farmers use lake water to irrigate crops. The effect of very large lakes on climate also helps farmers. Because water does not heat or cool as rapidly as land does, winds blowing from lakes help keep the climate more even. This is the "lake effect." The city of Chicago, in the U.S. state of Illinois, benefits from the lake effect. Chicago sits on the shore of Lake Michigan. When the western part of Illinois is snowing, Chicago often remains slightly warmer.

The lake effect can help farmers. In autumn, lakes blow warmer air over the land, helping the season last longer so farmers can continue to grow their crops. In spring, cool lake winds help plants not to grow too soon and avoid the danger of early-spring frosts, which can kill the young crops.

Lakes supply many communities with water. Artificial lakes are used to store water for times of drought. Lakes formed by dams also provide hydroelectric energy. The water is channeled from the lake to drive generators that produce electricity.

Because they are often very beautiful, lakes are popular recreation and vacation spots. People seek out their sparkling waters to enjoy boating, swimming, water-skiing, fishing, sailing, and, in winter, ice skating, ice boating, and ice fishing. Many public parks are built near lakes, allowing people to picnic, camp, hike, bike, and enjoy the wildlife and scenery the lake provides.

For some people, lakes are permanent homes. For example, indigenous people called the Uros have lived on Lake Titicaca in the Andes Mountains for centuries. The lake supplies almost everything the Uros need. They catch fish from the lake and hunt water birds.

The Uros also use the reeds that grow in Lake Titicaca to build floating "islands" to live on. The islands are about 2 meters (6.5 feet) thick. On them, the Uros build reed houses and make reed sleeping mats, baskets, fishing boats, and sails. They also eat the roots and the celery-like stalks of the reeds.

Lake Health: Blue-Green Algae

Although lakes naturally age and die, people have sped up the process by polluting the water. A major problem that threatens many lakes is blue-green algae. Blue-green algae is sometimes referred to as "pond scum" and can be blue-green, blue, green, reddish-purple, or brown. It stays on the surface of the water and forms a sort of mat. When the conditions are just right, the algae multiplies quickly. This is called an algal bloom and is harmful to lakes, animals, plants, and people.

Blue-green algae is different from true algae because it is not eaten by other organisms. True algae is an important part of the food web because it supplies energy for tiny animals, which are then eaten by fish, which are then eaten by other fish, birds, animals, or people.

Blue-green algae, also called cyanobacteria, is not a part of the food web. It uses up important nutrients without contributing to the lake ecosystem. Instead, the algal bloom chokes up a lake and uses up the oxygen that fish and other living things depend on for survival. Plants die more quickly, sinking to the bottom and filling up the lake basin. Blue-green algae also can become so dense that it prevents light from penetrating the water, changing the chemistry and affecting species living below the surface.

When an algal bloom happens, water becomes contaminated. The toxic water can kill animals and make humans sick. Blue-green algae is not a new problem. Scientists have found evidence of it from hundreds of years ago. The problem has increased, though, as humans pollute lakes.

Eutrophication is when a lake gets too many nutrients, causing blue-green algae growth. How do the excess nutrients get into lakes? Sewage from towns and cities causes explosive growth of blue-green algae, and waste from factories can wash into the lakes and pollute them. Phosphorus-based fertilizers from farms, golf courses, parks, and even neighborhood lawns can wash into lakes and pollute them. The phosphorus seeps into the ground and eventually reaches the lake. Phosphorus is an important nutrient for a lake, but too much of it is not a good thing because it encourages blue-green algae.

How can blue-green algae be prevented or reduced? At home, people can help by using phosphorus-free fertilizer and by fertilizing only where it's needed. Preventing lawn clippings and leaves from washing into the gutter and maintaining a buffer of native plants help filter water and stop debris from washing away. Making sure septic systems don't have leaks, safely disposing of household chemicals (like paint), and minimizing activities that erode soil also help prevent the spread of blue-green algae.

Controlling phosphorous and chemicals from factories and farms is much more complicated. Citizens need to work with businesses and elected

leaders to help reduce the amount of runoff and water pollution.

Lake Health: Invasive Species

When a plant or animal species is moved to a location where it's not originally from, the species is called an exotic species. When that species harms the natural balance in an ecosystem, the species is called invasive. Invasive species can harm life in a lake by competing for the same resources that native species do. When introduced to new food sources, invasive species multiply quickly, crowding out the helpful native species until there are more invasive than native species.

Invasive species can change the natural habitat of the lake and are known as biological pollutants when this happens. Once non-native species have been introduced into a lake, they are almost impossible to get rid of.

How do invasive species invade in the first place? Non-native plants and animals are almost always introduced by people. As people use waterways more frequently, they may inadvertently move organisms from one area to another.

Plants such as Eurasian watermilfoil, an invasive aquatic plant in the U.S., may cling to boats, clothing, pets, equipment, and vehicles. Small animals such as the spiny water flea can travel unnoticed by hopping onto a kayak or other recreational equipment.

Species are also carried by large ships bringing goods from one country to another. These ships take in ballast water, which helps stabilize the ship as it crosses the ocean. When the ship reaches its destination, it releases the ballast water. The water may be full of non-native species accidentally captured as the ship took on ballast.

The most famous invasive species in lakes is probably the zebra mussel, a small mollusk native to the Black Sea and the Caspian Sea in Europe and Asia. In the late 1980s, zebra mussels were found in several of North America's Great Lakes. Since then, zebra mussels have spread to lakes from the U.S. state of Louisiana to the Canadian province of Quebec. Zebra mussels devastate native plants and animals. Some scientists say they carry

a type of disease that is deadly to birds that eat the mussels. Zebra mussels multiply so quickly that they clog pipes. This harms machinery at industrial plants that use water, including hydroelectric dams and water filtration plants. Ships, docks, anchors, and buoys have also been destroyed by the invasive zebra mussel.

Communities have worked to reduce the impact of invasive species. Many states have laws prohibiting the sale or transport of non-native species. People are encouraged to inspect their boats and other equipment for wildlife. Boaters should remove plants, animals, and mud before leaving the water-access area. They should also drain any water from their boat. Rinsing boats, equipment, and even people can help reduce the transfer of harmful species. People should also get rid of leftover bait and report any species they see that look like they might not be native. These steps can make a big difference in keeping the habitat of a lake healthy.

Lake Health: Acid Rain

Another major threat to lakes today is acid rain. Some acid is natural, even in pure rain. This slightly toxic chemical slowly weathers rocks and soil. Acid rain, however, is caused by human activities and is harmful. It is caused by toxic gases from factories, coal-fired power plants, vehicle exhaust, and home furnaces.

Nitrogen and sulfur, the main ingredients of acid rain, rise in the air and may be carried hundreds of kilometers by wind. When these gases mix with the moisture in clouds, they form strong acids, which kill fish, plants, and other organisms when the acids fall as rain or snow on lakes. Acid rain can also affect humans, causing asthma and bronchitis, and damaging lung tissue. Methylmercury, a toxic form of mercury, has been linked to acid rain. Eating fish containing high levels of this mercury is particularly harmful for pregnant women, the elderly, and children.

Lakes and soil can neutralize normal levels of acid, but acid rain is too strong for lakes to combat. Eventually, acid rain leaves lakes sterile and lifeless. There are many lakes today in the United States, Canada, and parts of Europe dead or drying up because of acid rain.

Some steps have been taken to curb acid rain. The Clean Air Act was passed

by the United States Congress in 1990. It required all utility companies to reduce the amount of toxic emissions by 40 percent by the year 2000. At home, people can help the problem by replacing old furnaces, turning off electronics when they're not being used, and using fans or opening windows in the summer instead of air conditioning. Using compact fluorescent light bulbs (CFLs) and energy-efficient vehicles also help reduce the amount of pollution going into the air.

Lakes are among the most valuable and most beautiful of the Earth's resources. Most experts agree that lakes must be kept clean and free from pollution if they are to continue to provide the many benefits that we receive from them today.

FAST FACT

Lake District

The Lake District is a famous wilderness area in northern England. Lake District National Park is one of the countrys most popular parks. Besides lakes, the Lake District is filled with mountains and hills, valleys and streams, bogs and plains. The Lake District was a favorite place of the so-called Lake Poets, a group of 19th-century English writers including William Wordsworth and Samuel Taylor Coleridge.

FAST FACT

Lake Vostok

Lake Vostok, in Antarctica, is one of the largest subglacial lakes in the world. Lake Vostok is about the same size as Lake Ontario, and even has an island in the middle of it. On top of the lake is an icecap 4 kilometers (2.5 miles) thick. The ice actually insulates the water, preventing it from freezing.

FAST FACT

A Lake by Any Other Name

A mere is a large, shallow lake. Meres are common in the United Kingdom,

while meers (the Dutch word for lake) are found in the Netherlands.

Lochs are lakes or bays mostly found in Scotland.

Articles & Profiles

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