RIVERS AND STREAMS

Running water is essential in supporting aquatic organisms because the constant movement aerates the water, providing oxygen. The movement of water also keeps nutrients available and flushes wastes further downstream. Running water can cause some loss of life, such as experienced during a flood, with organisms moved downstream, into flood plains and away from flowing water or unable to survive the increased flow and dying.
Illinois is bordered by 880 miles of rivers and has 106,900 miles of rivers and streams within its borders. It is estimated that the surface area of Illinois' interior rivers and streams is 325,000 acres.

Definition

Rivers and streams are deep water habitats contained within a channel. If water flows through the channel throughout the year, the river or stream is called a perennial stream. An intermittent stream has water flowing only part of the year. The smaller streams that feed into larger rivers and streams are tributaries. The land adjacent to a river or stream that is periodically flooded is the flood plain.

Young or immature streams are short and flow swiftly, thus the rate of erosion is great. The channels of these streams are usually straight, with a v-shaped bottom. Older or mature streams have wide, flat-bottomed, or u-shaped channels. The water flows slower, and the rate of erosion is less. It is a natural process for bodies of water to evolve. Water is dynamic, not static.

The rate water flows within a channel is called velocity. Many factors can influence the velocity of water. The gradient (pitch) of the channel, volume of water flowing and amount of area the stream drains (watershed) influence the flow of water. Recent precipitation, or the lack of, will contribute to the stream's velocity. Stream flow is also affected by the composition or type of material in the stream bed (sand, silt, mud, gravel, bedrock).

Each river and stream has a watershed, or drainage basin, the total land area that provides water to the river or stream. Along with the surface water runoff, these bodies of water receive sedimentation and other materials from the watershed. Many rivers flood regularly, increasing productivity and enriching flood plains with rich sediment and nutrients. Changes to the Mississippi and Illinois rivers, such as levees and locks and dams, have diminished natural flooding cycles and reduced productivity of these systems. While flooding may be a problem for humans, it is an important natural process for rivers.

The vegetation growing adjacent to flowing water is called riparian vegetation. This plant zone provides shade to the water body, slows the rate of erosion and decreases the amount of silt flowing into the water. Characteristic plants growing in riparian zones in Illinois include willows, cottonwood, sycamore, box elder, sedges, bulrushes, cattails, buttonbush and touch-me-not.

Meanders (curves) form in older, slower flowing streams as their channels migrate along the path of least resistance. During floods, the additional volume and velocity of water will often cut off the meander, forming a chute. As the flood subsides and the water loses velocity, sediment drops out of the water column. Sediments may form a sandbar, creating a natural dike between the chute and the old meander. Thus, an oxbow lake is formed where the meander used to be. The sediment that is left behind during these natural stream migrations is called alluvium.

With the constant flow of water, temperatures in rivers and streams vary. Stream velocity, the amount of water directly exposed to sunlight and volume of water can alter water temperature.

As water flows over structures in the channel, aeration occurs. The amount of oxygen in water is dissolved oxygen, or "DO." The addition of oxygen to a water body is important in providing the oxygen needed for many aquatic organisms. In some instances you can determine the general quantity of dissolved oxygen in the water by the presence or absence of certain organisms. Pike and trout require medium to high levels of dissolved oxygen, while carp and catfish survive in waters having low dissolved oxygen. Waters with high dissolved oxygen support a large variety of aquatic creatures including mayfly nymphs, stonefly nymphs, caddisfly larvae and beetle larvae. As dissolved oxygen levels drop, these species disappear and are replaced with aquatic worms, fly larvae and outbreaks of algae populations.

Life in a Stream

Aquatic organisms are often categorized by where they live in the water column: benthic; pelagic; and surface. Benthic organisms live on the stream substrate and feed on plant and animal materials that collect on the bottom. Crayfish, mussels, and stonefly and mayfly larvae are examples of benthic organisms. Pelagic organisms live within the water column. These organisms may float or swim and include fishes, frogs, turtles, water lilies and a variety of insects. The final category is the surface dwelling organisms, such as water striders, duckweeds and adult dragonflies and damselflies.

The place organisms live within a stream or river is primarily determined by how well they can deal with water currents. Some organisms that live in swift water have adaptations that allow them to anchor to the substrate (stonefly and mayfly nymphs). Others seek out more protected areas in the water, like behind large rocks or in pools (water strider, fish). Life in swift water provides abundant food supplies flowing downstream and highly oxygenated water.

Historical Perspective
Illinois has been part of the central lowland of the North American continent for at least the last 300 million years. The Ice Age had major impacts on Illinois and its rivers. Glaciers blocked and buried some rivers and created new ones. Ancient rivers, such as the Teays, Cumberland, Paw Paw and Ticona, no longer exist. The Missouri River once flowed in much of what is now the Mississippi River bed but was blocked and filled during the Kansas (second) glacier and diverted to a new channel. The Teays River was diverted south of the glacier and became the Ohio River. The Ohio River was where the Cache River is now.

Ecological Importance
Many of the river backwaters, deep glacial lakes and wet prairies historically found in Illinois have been drained or seriously disturbed. More than 87,110 miles of streams exist in Illinois. More than half have been degraded in some manner – dredging, damming, pollution, siltation or presence of exotic plants, fishes or mussels.

Many rivers rely on flooding to increase productivity and enrich flood plains with sediment and nutrients. Changes to the Illinois and Mississippi rivers through construction of levees and locks and dams have diminished the natural flooding cycle and reduced productivity of these systems.

Economic Importance
Water is the cornerstone of much of our recreation – from boating, canoeing and fishing to skiing, scuba diving and swimming. Fishing, hunting and trapping of aquatic life provide recreational opportunities and supplement the table with food and may provide fur for clothing. Many rivers, streams and lakes attract tourists and support area businesses.

River corridors continue to be used for shipping produce and manufactured goods downstream. Rivers and streams dammed to create a reservoir may provide recreational opportunities, generate electricity, supply homes and agricultural lands with water and store flood waters. Damming of rivers and streams does, however, result in the loss of almost all the habitat features and amenities which depend upon and are produced by flowing water.

Soils can be eroded and moved downstream by wind, rain or glaciers. Though erosion is a natural process, many human practices accelerate the erosion process. Soil particles can be picked up by wind or water when trees are cleared or prairie grasses or other terrestrial herbaceous vegetation is removed, either by people or when cattle over-graze the site. Soil particles in water can kill bottom-dwelling organisms, clog the gills of fishes and mussels and destroy spawning habitat. Herbicides, pesticides and other chemicals attached to soil particles can kill or severely injure populations of aquatic organisms.

Removal of sediment is a costly process. Navigational channels must be periodically dredged to maintain an area for travel and for barges transporting products. Destruction of vegetation in a watershed may result in erosion and the filling of a lake or reservoir. As a result, the water body may have diminished appeal for recreation. A decreased capacity for water storage provides less water for human, agricultural or industrial use or for flood storage.

Management Practices
Management of streams and rivers requires protecting habitat essential to the aquatic organisms. Activities within the watershed greatly affect the quality of water. Controlling erosion includes minimizing the amount of soil that is exposed to air and water. Projects and activities should be designed to minimize the amount of soil disturbed. Conservation farm practices may include covering the soil, leaving a crop residue or planting vegetation in the area.

Protection of aquatic resources may require zoning to prevent construction along the banks of the water body. Water pollution is categorized as nonpoint (from a land practice such as agriculture or construction), municipal (wastewater and storm runoff), industrial (chemical discharge from industry) and dredged (removal which also stirs up sediment). Water quality can be improved by minimizing the amount of activity leading to any and all of these types of pollution.

Aquatic resources may also be managed by enhancing the resource. In streams, wing dams may be built from the bank. Water flowing across the wing dam cuts a deep pool for fish on the downstream side of the dam. Other structures are placed in the bank to provide overhangs for shade and spawning (catfish and smallmouth bass).

Issues
Illinois' agricultural landscape impacts aquatic habitats. The chemicals used to increase crop production and decrease crop pests wash into lakes and streams. Contaminants that enter the water column eventually enter fish flesh. These contaminants may make fishes unfit to eat. Bottom feeders and large predatory gamefish often concentrate large quantities of contaminants in their flesh due to their food habits and longevity.

Invasive species, such as the zebra mussel, cause serious threats to native aquatic life.

LAKES, PONDS, RESERVOIRS

More than 2,900 lakes, 84,000 ponds and three large reservoirs are found across Illinois. Lakes are generally considered to be nonfree-flowing (lentic) bodies of water 20 or more acres in size, while ponds are nonfree-flowing bodies of water smaller than lakes (IDNR 1988). Illinois contains a variety of lake types. Northern Illinois is home to glacial lakes which were created thousands of years ago as glaciers advanced and receded. Oxbow lakes are formed when a meandering stream cuts a new and straighter channel. The old bend in the stream, now cut off from the main channel, becomes a lake. Impoundments and reservoirs are created by obstructing the flow of a river with a dam or berm. These water bodies are often used for public water supplies. Ponds and stormwater detention basins are built by excavation or by expansion of an existing lowland area.

Lake ecosystems are complex and varied. Oligotrophic lakes tend to be unproductive in terms of organisms present, have high levels of dissolved oxygen and contain very clear water. Lakes that have many particulates present, low dissolved oxygen and are highly productive with large populations of plants, animals and plankton are eutrophic. Mesotrophic lakes fall between the two extremes found in oligotrophic and eutrophic lakes. Within the lake there are specifically adapted organisms. Bottom dwellers are known as benthic organisms. Free-swimming organisms are called nekton. Plankton are small, free-floating organisms. Neuston are organisms that live on the surface film of water, like water striders, duckweeds, mosquito larvae and whirligig beetles. Those lakes with the greatest diversity of species tend to be the most stable. However, changing or disturbing even one component of the ecosystem affects all of the other components. Although the effects may not be seen immediately, they will occur.

Lakes are the least permanent and probably the most fragile part of Illinois' surface water system. All lakes are considered to be temporary because over time they fill in through the process of eutrophication. Because water moves much more slowly through a lake than it does through a stream, lakes act as settling basins. Inflowing solid and dissolved substances, natural and synthetic, may drop out of the water and build up on the bottom. Seepage lakes are fed primarily by ground water, while drainage lakes are fed by surface runoff and tributary streams. Drainage lakes tend to show immediate responses to dramatic precipitation changes. However, seepage lakes may show little change in water levels during prolonged dry periods because the ground water supplying them tends to remain fairly constant. If a seepage lake is affected by a severe drought, it may take several years for water levels to return to normal. Changes in the watershed may also affect the lake's water balance. Undeveloped land tends to absorb rainfall and release it slowly. Yet when land is covered with impervious structures like roads and parking lots, precipitation runs off quickly and may change water levels in lakes drastically.

Physical Properties
Many Illinois lakes are deep enough to stratify, or form layers of water with different temperatures. Stratification occurs because water's density changes with its temperature. Water is densest at 39°F. Above and below that point, water becomes lighter. In very shallow lakes, stratification does not occur because wind and wave action keep the water molecules mixed throughout.

In the fall, air temperatures cool the surface waters of a lake to 39°F. When the water reaches this point, it sinks (fall turnover). As the lake continues to cool, the colder water (32°F) is pushed to the top and may form ice. When spring arrives, the surface waters begin to warm. As they reach 39°F they sink and mix with the deeper water (spring turnover). As the season progresses, the temperature differences between the upper and lower regions of the lake increase. In lakes deeper than about 10 to 12 feet, the lake stratifies into three layers. The upper layer, or epilimnion, extends down about eight to 15 feet from the surface and is the warmest layer. The middle layer, also know as the metalimnion or thermocline, is narrow and exhibits falling temperatures with increasing depth. Below the thermocline to the lake bottom exists the hypolimnion which has the coolest lake waters.

Temperature is one of the key factors that regulates the kind of species that can live in our lakes. The amount of dissolved gases that water holds varies with the temperature. Warm water, for instance, holds much less oxygen than cold water.

Temperature also affects feeding, growth and reproduction of many aquatic organisms.

Biological Properties
Lakes may be divided into three biological zones. The littoral zone extends into the lake from the shoreline. Macroinvertebrates, bacteria, rooted aquatic plants, algae, aquatic vertebrates and other organisms are numerous here. Wetlands often border at least part of the lake's shore. Light penetrates to the bottom of this zone.

The open water part of a lake is the limnetic zone. Phytoplankton, zooplankton and fish are found here. Since photosynthesis can only occur where light is present, the transparency of the limnetic zone affects the productivity of the phytoplankton and therefore the amount of oxygen produced.

Deep lakes may have a profundal zone. This zone receives little or no sunlight. Bacteria, fungi and other decomposing organisms thrive on the organic matter that falls from the upper layers of the lake. Large amounts of oxygen are used in decomposition, and the profundal zone is known for being deficient in oxygen.

Chemical Properties
Dissolved Oxygen (DO)
The amount of oxygen dissolved in a lake's water has a dramatic effect on the organisms present. Under normal conditions water contains 30 times less oxygen per given volume than air. Oxygen may enter a lake by diffusion from the atmosphere and by photosynthesis. Factors affecting dissolved oxygen levels include photosynthetic activity, wind and wave action, the amount of decomposing organic matter, time of day, salinity, atmospheric pressure, volume of water and temperature. Winter can be particularly stressful for a lake's aquatic life. Ice may seal off atmospheric oxygen. A layer of snow may block sunlight penetration through the ice. If these conditions persist for a lengthy period, oxygen-producing organisms may die while decomposition and respiration for other organisms continues. Oxygen levels may fall so low that a winter kill occurs.

Biochemical Oxygen Demand (BOD)
Biochemical oxygen demand measures the amount of oxygen used by microscopic organisms as they decompose organic materials. Increased quantities of plant life in a water body usually lead to increased levels of BOD. Increased levels of organic wastes also lead to increased BOD. Sources include natural waste material, such as leaves, factories/processing plants, agricultural runoff and wastewater treatment plants.

In water bodies with high BOD levels, most of the available oxygen is used in the process of decomposition. Aquatic life must be tolerant of low oxygen levels, move or die. When this condition occurs, organisms that thrive in low oxygen may flourish.

Total Solids
Total solids includes both dissolved solids (pass through a filter) and suspended solids (trapped by a filter). The category includes living and nonliving items. Typical inorganic components are the result of weathering and soil erosion in the watershed and resuspension of sediments. Suspended solids may contain excess nutrients, pesticides and toxins. Organic suspended solids are mainly algae and decaying organic matter. High concentrations of total solids may lead to the following problems: a laxative effect in drinking water; an unpleasant taste in drinking water; reduced water clarity; decreased photosynthesis; and an increase in water temperature. Low concentrations of total solids may limit growth of aquatic life.

Turbidity
Turbidity (cloudiness) measures the clarity of water. The more suspended solids in the water, the higher the turbidity. Some turbidity is normal from dissolved organic matter, sediment and minerals. Increases above normal levels may be caused by soil erosion, waste discharge, runoff and other factors. High turbidity leads to warmer water, lower oxygen levels and less photosynthesis. It can clog fish gills, reduce growth, reduce disease resistance, cover eggs and larvae and eliminate habitat.
Total Phosphorus

In many lakes the amount of phosphorus present controls the amount of plants present. This essential nutrient can also cause problems if it is present in significant quantities. Phosphorus added from sewage treatment plants, lawn and farm fertilizers, poor septic systems or other sources leads to increased growth of algae and aquatic plants, sometimes to detrimental effect. Lakes are referred to as "young," " middle-aged" or "old." High levels of phosphorus continually being added to a lake, or phosphorus loading, can cause eutrophication, in which the lake ages before its time.

Phosphorus is measured in parts per billion (PPB). To give you an idea of the dimensions of this measurement, one part per billion would be like one pinch of salt for every 10 tons of potato chips or one second in 32 years or one drop of water in 500 barrels of soft drink.

Nitrogen
Nitrogen is used by organisms to build proteins. It is very abundant in its molecular form, but most organisms cannot use it in this form. Some species of blue-green algae are able to use nitrogen directly from the atmosphere. They also convert it into forms that aquatic plants can use, namely ammonia and nitrate. Nitrogen is then passed to aquatic animals as they eat the plants or organisms that have eaten the plants. Decomposition of organic matter and excretions of aquatic animals may contribute large amounts of nitrogen compounds into the water, leading to eutrophication. Ammonia, a nitrogen compound formed during organic decomposition, can be toxic to aquatic life in significant quantities.

pH
The pH scale measures the hydrogen ion concentration of substances and ranges from 0-14. Neutral solutions have equal amounts of hydrogen ions and hydroxide ions, with a pH of 7. If a substance has more hydrogen ions than hydroxide ions, its pH is between 0 and 7 and is considered acidic. If a substance has more hydroxide ions than hydrogen ions, its pH is between 7 and 14, and it is considered basic. For every one unit change in pH, there is a ten-fold change in the acidic or basic content of the sample. Many factors can affect pH, including acid rain or snow and the types of rocks and minerals found in the area.

Under normal conditions most Illinois lakes have a pH between 6.5 and 9. Although rainwater in Illinois is slightly acidic (about 4.4), most lakes are able to offset this acidity by naturally occurring buffering compounds in the water. A pH reading of below 5 is considered critical and damage to the gills of aquatic organisms may occur. Readings of 5 to 6 are rated as endangering because this level of acidity is toxic to some organisms. Readings between 6 and 8 are considered satisfactory.

Fecal Coliform
Fecal coliform bacteria are found in the solid wastes of humans and other warm-blooded animals. These bacteria can enter water bodies through direct release by animals, from runoff carrying animal wastes and from human sewage. Fecal coliform bacteria naturally occur in the digestive tracts of warm-blooded animals. Pathogenic bacteria may be present along with the fecal coliform bacteria. If fecal coliform counts are high for an area, there is an increased chance that pathogenic organisms are present, too. Pathogenic organisms are usually not sampled directly because they are few in number and difficult to count. Fecal coliform results are stated as number of colony forming units (CFU) per 100 ml of water.

No fecal coliforms should be present in drinking water. A range of 200-1,000 CFU per 100 ml of water is safe for swimming, although people often swallow water when swimming and chances of infection are great. CFU readings of 1,000-5,000 per 100 ml of water are considered safe for activities like boating and fishing. Ear infections, dysentery and hepatitis may be contracted in areas with high fecal coliform counts.

Temperature
Temperature of the water directly affects the amount of dissolved oxygen present, chemical concentrations, rate of photosynthesis, metabolic rate of aquatic organisms and sensitivity to diseases and parasites. Water has a high heat capacity and resists temperature change. Cool water holds more oxygen than warm water. Thermal pollution occurs when warm water is added to a natural body of water, generally by industries, dams and runoff. Actions such as clearing shoreline vegetation may cause an increase in water temperature. Soil erosion contributes to warmer water because the suspended soil particles absorb heat.

Most aquatic species are acclimated to specific ranges of water temperatures. As the temperature changes, those species that are adapted to one range of temperatures will be replaced by those that are tolerant of the new temperature. At temperatures greater than 68°F, many plants and fish diseases thrive, as do most bass, crappie, bluegill, carp, catfish and caddisflies. Temperatures in the range of 55-68°F support some plants and some fish diseases along with salmon, trout, stoneflies, mayflies, caddisflies and water beetles. Water temperatures below 55°F are habitable for trout, caddisflies, stoneflies and mayflies. Rapidly changing water temperatures can cause thermal stress to aquatic organisms.