Illinois Aquatics

SURFACE WATER AND GROUND WATER

Hydrology is the study of the movement and distribution of waters. Water may be found in the ground (aquifers), on the surface (lakes, rivers, ponds, streams, wetlands) and in the atmosphere (precipitation, clouds and airborne toxins). Water is also found in all organisms and is essential to life. Water is a renewable natural resource and changes forms through the water cycle.

About 97 percent of the earth's water is salt water, with most of it in the oceans. The remaining three percent is found in freshwater rivers, ponds, lakes, icecaps, water vapor, ground water and in organisms. The two most available sources of fresh water are surface water and ground water. The other main source of fresh water is the ice in the polar regions.

Illinois is a very water-rich state. Water practically surrounds Illinois, as it is bordered by three major rivers and one Great Lake. Illinois receives 35 to 42 inches of rainfall each year and has vast groundwater supplies. The citizens of Illinois use a tremendous amount of water annually with a 1985 study ranking Illinois fourth in the United States for the amount of average fresh water withdrawals per day (U.S.G.S. 1987).

Surface Water
Surface water includes permanent, open bodies of water 0.1 acre or larger. They are separated from wetlands by their permanence and by their general lack of emergent woody vegetation. There are four subclasses of surface water in Illinois: Lake Michigan; flowing waters; impoundments; and reservoirs. Combined, these four categories total more than 1.6 million acres of surface water.

Only about seven percent (976,640 acres) of Lake Michigan is within the state of Illinois' jurisdiction and only that portion will be referred to here. This amount accounts for about 61 percent of the surface water of Illinois. Lake Michigan borders Cook and Lake counties.

The flowing water classification includes streams, canals, creeks (small streams) and rivers. Streams make up about 20 percent (325,000 acres) of Illinois surface water with the majority of the streams found in southern and western Illinois. Henderson (21,388 acres), Calhoun (20,838 acres), Rock Island (14,359 acres), Hancock (12,899 acres) and Carroll (12,514 acres) are the five counties with the most stream acreage (IDNR 1996).

Impoundments are standing bodies of water constructed by artificial means or formed by nature, excluding Lake Michigan and the three reservoirs mentioned in the next paragraph. About 16 percent (259,400 acres) of Illinois' surface water is contained in impoundments. The majority of the impoundments are found in the southern and western regions of the state. Forty-three percent of the impoundments are privately owned, followed by 32 percent that are publicly owned, 15 percent state owned, 9 percent organization owned and 1 percent commercially owned. The top five counties in regard to impoundment acreage are Lake (14,739 acres), Mason (14,246 acres), Williamson (12,615 acres), Fulton (12,052 acres) and Cook (7,858 acres).

The reservoir classification in Illinois covers only the three reservoirs constructed by the U.S. Army Corps of Engineers. They total 54,580 acres, or three percent of the surface water in Illinois. Lake Carlyle covers 24,580 acres in Fayette, Bond and Clinton counties. Rend Lake occupies 18,900 acres in Jefferson and Franklin counties. Lake Shelbyville covers 11,100 acres in Shelby and Moultrie counties.

Ground Water
Ground water results from precipitation. This precipitation percolates under the surface of the earth and fills the cracks, crevices and tiny pores between soil and rock particles much like water saturates a sponge. It may remain undisturbed for years, even centuries, or it may flow into wells drilled into the ground or flow out of the ground as springs. Ground water moves an average of three inches per day, depending on the porosity of the rock. Ground water is affected by the type of soil in the area. Permeability ranges from 0.06 inches per hour in some clay soils to more than 20 inches per hour in some sandy soils.

The major users of ground water in Illinois are public water supply (47 percent), industry (21 percent), agriculture (21 percent) and private water supply (11 percent). About 50 percent of Illinois' population uses ground water from wells for drinking. Almost all of the people (98 percent) who live in rural areas draw their drinking water from wells. About 75 percent of Illinois' community water systems use ground water. More than 410,000 wells are used to tap the ground water

in Illinois. Almost all Illinois ground water is recharged, or replenished, locally. About 15 percent of the potential ground water supply is presently being used. Water wells range in depth from 20 feet to more than 2,800 feet.

Although less than eight percent of the tested Illinois community water wells show measurable levels of contamination, ground water may be contaminated. In some areas of Illinois, the ground water is contaminated with naturally occurring minerals, like calcium and magnesium, which makes the water "hard." In parts of northern and western Illinois, radium in deep, bedrock aquifers exceeds the drinking water standard.

Ground water may be contaminated by other sources, too. Gasoline and other harmful liquids have leaked from underground storage tanks into ground water. Pollutants can seep into ground water from poorly constructed landfills or septic systems. Ground water may be polluted by runoff from fertilized fields, livestock areas, abandoned mines, salted roads and industrial areas. Homeowners can contribute to contamination by dumping household chemicals down the drain or pouring them on the ground. Also, because ground water moves so slowly, the contamination is likely to remain concentrated and close to the point where the pollution occurred.

Ground water contaminated with bacteria, chemicals, pesticides, gas or oil can result in serious health problems. Overuse of farm chemicals can pollute ground water with nitrates, and people and/or animals who drink the water can be poisoned. Contaminated ground water can be cleaned up, but it is very expensive and time-consuming to do so.

Legislation
Illinois has tried to reduce the threat to its ground water by expanding and unifying the state's ground water protection programs. In 1987, the General Assembly passed the Illinois Ground Water Protection Act. The Ground Water Protection Act is a comprehensive law that deals with three types of potentially contaminating land uses. Potential primary sources of contamination include disposal and storage sites that handle large amounts of hazardous materials and any amount of hazardous waste. Potential secondary sources of contamination include facilities that store smaller amounts of hazardous materials, for example, agricultural chemical facilities, storage sites for de-icing salt, wastewater treatment plants and above- and below-ground petroleum storage tanks. Potential routes of contamination are possible pathways for contaminants and include abandoned wells, drainage wells and sand and gravel mining operations. Several agencies assist in making sure that the provisions of the act are being carried out. Those agencies include the Illinois Environmental Protection Agency, Illinois Department of Natural Resources, Illinois Department of Public Health, Illinois Pollution Control Board and the Office of the State Fire Marshal.

WATER AS A RESOURCE

Water is one of the most common substances on earth, but it is also one of the most precious. Life cannot exist without it. It has been referred to as the "liquid of life." Water is the only substance on earth which can be found naturally in three separate forms--solid, liquid and gas. A single molecule of water can float as a vapor (gas) then fall to earth as rain (liquid) and then freeze into ice, sleet or snow (solid). Water is a finite resource--all the water we are ever going to have on earth is here now.

Who uses water?
Humans use water for many activities including cooking, bathing, washing clothes and dishes and brushing teeth. Factories and industries use water to manufacture things that people use, like clothes, paper, gasoline, electricity, plastic and glass. Water is also used in the mining process. Farmers use water to grow crops and raise animals for food. It takes about 15 gallons of water to grow the wheat to make one loaf of bread, about 120 gallons for a chicken to lay one egg and about 4,000 gallons to produce a pound of beef. People use water for recreational purposes such as swimming, boating and fishing. Barges carry people and goods on rivers and lakes. Water provides food and shelter for many organisms.

Every living thing on earth must have water. Even though it is a reusable resource, it must be shared by all water users and managed to ensure future supplies. Drinkable water is not free. Water treatment facilities and the distribution of drinking water are costly. Customers are charged according to the amount of water they use. A water meter is used to measure how many gallons or cubic feet a household or business uses. Because users pay for water and because there is only so much fresh water available for use, we must conserve our supplies, using them as wisely and efficiently as possible.
It is important to keep data related to water usage for governmental agencies, public-supply operators, water-resource managers and researchers for assessing current water-use patterns and anticipating future water demands. State water use data are collected and compiled by the Illinois State Water Survey in cooperation with the U.S. Geological Survey.

Where is Illinois' Water?
Illinois is a water-rich state and most of those riches flow through its streams and rivers. The state is bordered by three

major rivers: the Mississippi to the west and the Ohio and the Wabash to the south and east. Sixty-three shoreline miles (976,640 acres) of Lake Michigan, one of the five great freshwater lakes between the United States and Canada, create Illinois' northeast border. According to Illinois Environmental Protection Agency statistics, Illinois' 14 major river basins are drained by more than 106,900 miles of flowing water. This stream miles measurement figure constantly changes due to erosion, siltation and stream diversion. There are nearly 88,000 inland lakes and ponds (313,980 acres). Also, there are one million acres of wetlands and marshes, a tiny remnant of the original eight million acres that existed in the state. This system of streams, rivers, lakes and creeks is called surface water. Much of the water we use exists out of sight – underground. Ground water is the supply of water under the earth's surface that forms natural reservoirs. Although ground water accounts for only a fraction of the earth's supply of water, it is widely used for human consumption. Actually, it is more abundant than the water found in rivers, lakes and streams. Ground water accounts for 99 percent of the world's freshwater supply. Forty-seven percent of the public water supply in Illinois comes from ground water; industry extracts 21 percent, another 21 percent is used for agricultural purposes and those who have private water supplies use 11 percent.

Figure 1

Self-supplied vs. Public Water Supplies

Self-supplied, or private, water is water withdrawn from a surface or ground water source by a user rather than being obtained from a public supply. There are nearly 400,000 private wells in Illinois which serve approximately 1.3 million people (see Figure 2). A public water supply is water withdrawn by public and private water suppliers and delivered to groups of users. Public suppliers provide water for a variety of uses, such as domestic, commercial, hydroelectric power generation, industrial and public water use. Water provided by public water suppliers or water that is self-supplied can

come from surface water or ground water.

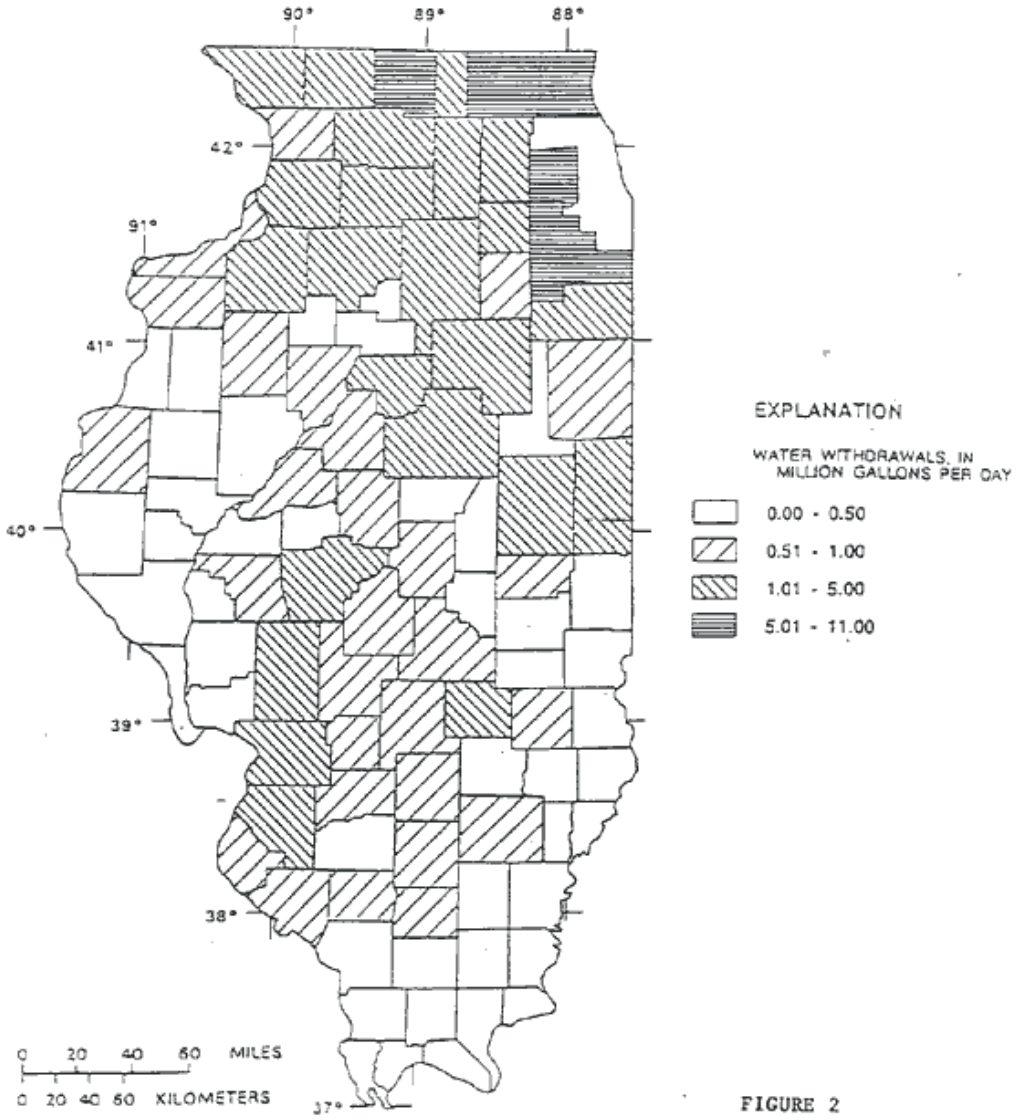


FIGURE 2

Estimated self-supplied domestic withdrawals of water in Illinois

The self-supplied population is the difference between the total county population and the population served by public water supply. Eighty percent of the population of Illinois is served by public-supply facilities. In 1990 the largest supply of surface water withdrawals for public supply were from Lake Michigan, the Mississippi River and the Sangamon River (see Figure 3. The largest withdrawals of ground water for public supply were in Champaign, Cook, Du Page, Kane, Lake, La Salle, McHenry, Madison, Peoria, Tazewell, Will and Winnebago counties (see Figure 4). Although many commercial and industrial water users purchase water from public water supplies, a number of large users develop their own water supplies. This process creates competition between industry and domestic users for the same water supplies. Nearly all the self-supplied industry in Illinois can be divided into four major classifications: thermoelectric power generation, hydroelectric power generation, manufacturing and mineral extraction.

Uses of Water in Illinois

Drinking Water: There are several sources of drinking water in Illinois. One source is surface water from rivers and lakes. Almost half of Illinois residents rely on a second source, ground water, to meet their daily water needs. Lake Michigan supports drinking water uses for the northeastern portion of the state. Approximately 1.1 billion gallons per day are removed from Lake Michigan for people to use.

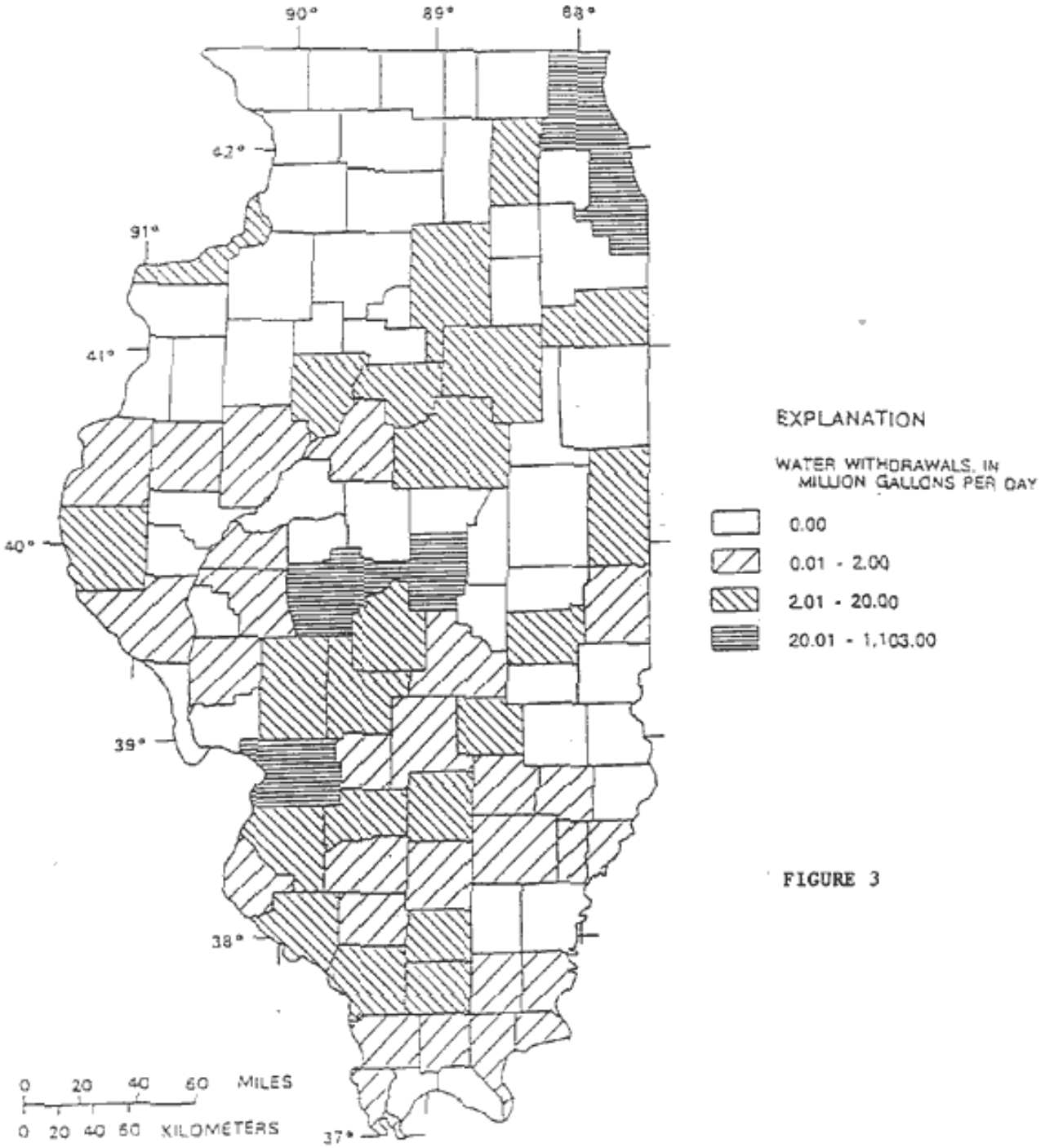
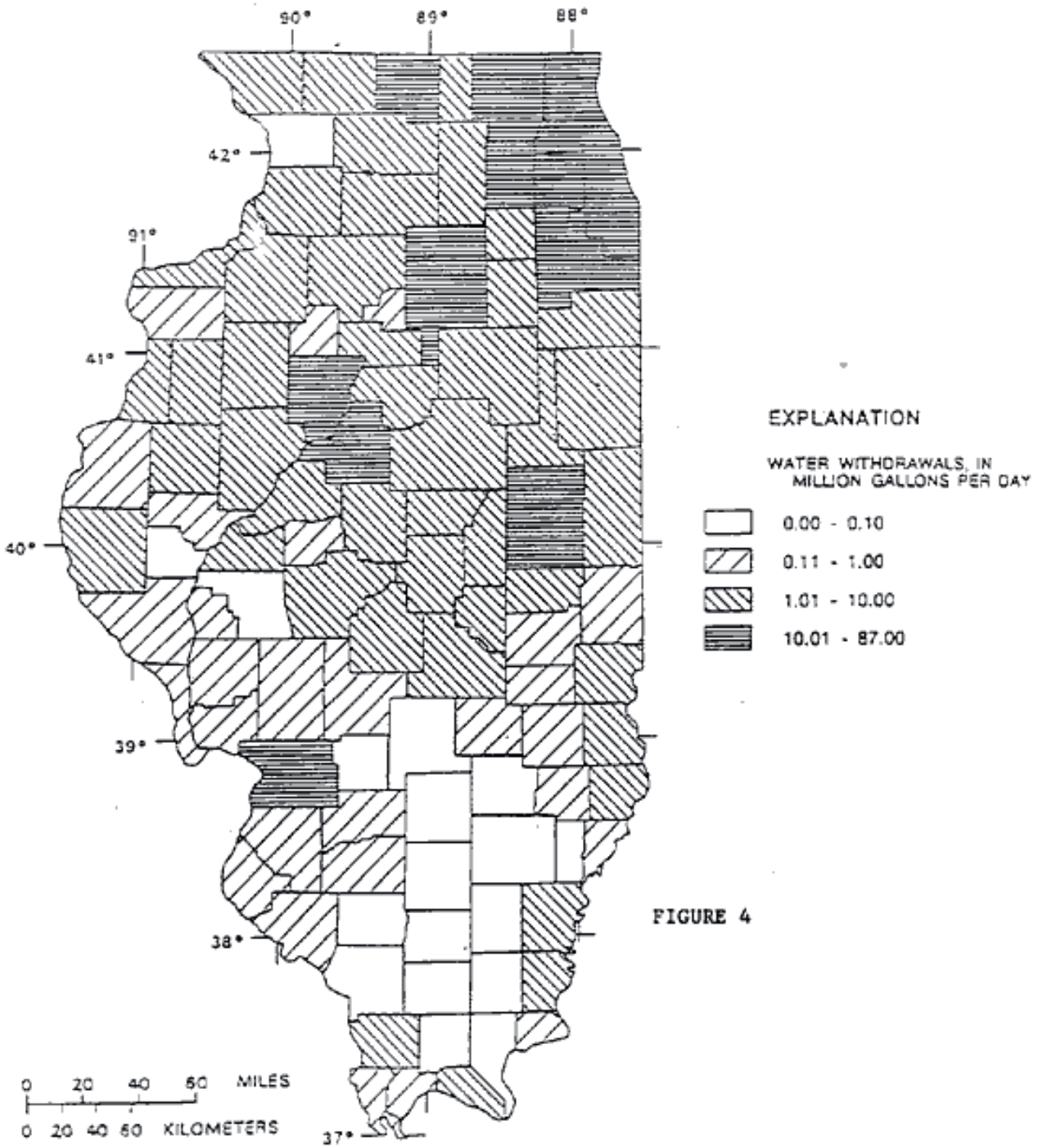


FIGURE 3

Public-supply withdrawals of surface water in Illinois

Agricultural: Although irrigation uses relatively small amounts of water in terms of total withdrawal, it is a major water use in some areas of the state. According to the 1992 Census of Agriculture, Illinois has 2,061 farms that use irrigation, which calculates into 328,316 irrigated acres. Water for irrigation is applied during the growing season of May-August, but the total water used is averaged over the entire year. The source of most irrigation water is ground water.

Water use for livestock purposes is determined by multiplying the county population of each major type of farm animal by



Public-supply withdrawals of ground water in Illinois

FIGURE 4

the estimated water directly consumed by the animal and other water used in association with the animal (Kirk 1987). The total amount of water for livestock and animal specialties used in 1990 was 62.74 million gallons per day in Illinois.

Personal Hygiene and Other Uses*:* People use water for bathing, washing clothes and dishes and brushing teeth, as well as cooking and other uses. The average water user in the United States uses 80 to 100 gallons of water per day.

According to the 1995 Illinois Water Uses Summary published by the Illinois State Water Survey, the total water withdrawal (reported and estimated) in 1995 in Illinois was 1.9 billion gallons per day. Surface water furnished 1,496.74

million gallons per day (mgd) while ground water supplied 368.93 mgd. The largest public water system is the Chicago Department of Water which services more than 5 million people within Chicago and the outlying areas. This system pumped 1,050.02 mgd from Lake Michigan in 1995. The largest area served by a public water supply system is the Rend Lake Conservancy District in southern Illinois. Reaching into parts of nine counties (Franklin, Jackson, Jefferson, Hamilton, Marion, Perry, Saline, Washington and Williamson), this conservancy district serves an area of more than 1,800 square miles. It pumped 12.87 mgd from Rend Lake in 1995.

Industrial: The total amount of self-supplied and public-supply delivery of water for industrial purposes in 1990 for the state was 727.72 million gallons per day.

Mining: Water is an important part of the mining process. Coal mining in southern Illinois consists of both surface and underground operations which utilize little to no ground water for a consumptive purpose. Water is used to keep coal dust down in the mines during coal extraction. Water is also used to wash coal after it is extracted. Coal mine use in Illinois is approximately 200,000 gallons per day per mine. Some of which can be recycled. Varied amounts of ground water must be removed in both types of mining. It is typically pumped out of the mine and discharged off the site through a regularly monitored discharge point which must meet state and federal regulations. The coal mining operator is required to replace any drinking water supply that is interrupted as a result of the mining operations. Even though surface and ground water are closely monitored by the Illinois Department of Natural Resources, ground water removal is not typically quantified.

Transportation: The Mississippi, Illinois, Ohio and Kaskaskia rivers are equipped with locks, dams and maintained channels. They serve as important transportation routes for commercial navigation in and through Illinois and add to Illinois' rich aquatic history.

Recreation: There are 328,139 acres of water areas open to the public in Illinois for recreation purposes. Recreation and leisure are important parts of the day-to-day lives of most people. Swimming, fishing, hunting, trapping, boating, skiing, snowmobiling and observing wildlife are the major water-related activities. They provide the opportunity to enjoy the outdoors and contribute to our state's economy, bringing in millions of dollars from licenses, permits and registrations. They also contribute to local economies in the form of hotels, restaurants and gasoline. Sportfishing alone is estimated to produce annual expenditures of $916 million statewide.

Illinois has 63 miles of Lake Michigan shoreline, 40 miles of which is publicly owned and devoted to open space and recreation. Ranging from Chicago's public beaches, parks, marinas and museums to Illinois Beach State Park's sand dunes, marsh and miles of natural beach, the Lake Michigan shoreline offers a rare mixture of active and passive recreational and scenic opportunities. In the midst of the Midwest's largest concentration of people, the Lake Michigan shoreline has the potential to impact the most people – both Illinois residents and tourists – of any of Illinois' recreational and scenic sites.

Education: Bodies of water and wetland areas provide field laboratories for students in the natural or physical sciences.

Habitat: The land/water connection is an extremely rich wildlife habitat due to the abundance of water, nutrients from plant decay and diverse vegetation providing both food and cover for hundreds of species of fish and wildlife. Many valuable plant and animal species are either located in wetlands or dependent upon them. The Illinois Wetlands Inventory (IDNR 1996) has identified 617 types of wetlands and deepwater habitats in our state. They provide food and shelter for 40 percent of the state's endangered or threatened species and serve as spawning grounds for many fish and shellfish. Wetlands are breeding, feeding and resting areas for waterfowl and shorebirds and also provide habitat for many species of insects, amphibians, reptiles, bacteria and other living organisms.

Utility Plants: The largest use of water in Illinois is for electric power generation – 94.9 percent of total water usage. The electric utility industry is usually listed as the single largest user of water. Most of the water is for cooling, which is a nonconsumptive use. For example, a large power plant which can generate enough electricity for a city of 500,000 people would use up to a billion gallons of cooling water per day. Drinking water and other consumptive uses in that city would amount to about 50 million gallons per day.

ADAPTATIONS

There is an amazing diversity of life on earth. Scientists estimate 40 to 80 million species of organisms live on earth, with a mere 1.5 million identified to date (Corson 1990). Illinois has about 54,000 identified species. A quick review of any one particular group of organisms reveals a wide array of subtle differences within the group. For instance, there are more than 200 fish species in Illinois, each with a distinct body shape, coloration, feeding habits and reproductive strategy.

These subtle differences are adaptations. An adaptation is an adjustment, often hereditary, that an organism goes through to live in a particular environment. Adaptations to the environment allow different organisms to fill different niches, or roles, in the environment. This partitioning minimizes competition for the same habitat requirements (food, water, cover, space). Adaptations develop over long periods of time and may be either a physical feature or a specialized behavior.

Because water covers about 75 percent of earth's surface, many adaptations are directly related to water. Most water is in motion. The movement of water and the changes that occur, either through natural or human processes, can make water a very difficult habitat to live in: gravity, the sun's energy and earth's rotation cause rivers to rush downstream or plunge over ledges to create spectacular waterfalls; they induce lakes and ponds to swirl below their surfaces and draw the ocean waves to shore. Gravity causes all free-running water to flow downhill. Wind also contributes to the movement of water. Currents can be weak or strong, water volume fluctuates, streams can dry up or flood, oxygen levels in water change with temperature changes, water density near the surface is different than at greater depths, water temperatures fluctuate according to depth, water freezes and pollution is easily spread. Not all plants organisms can live in water. Only those that have developed the special adaptations that enable them to withstand the inconsistency of water will survive.

Animal Adaptations
Adaptations increase an animal's chances of surviving in a particular environment and with a particular lifestyle. Animal adaptations may be a body shape to allow them to swim faster, a mouth shape to permit eating a particular type of food, a shape of the feet or legs to permit standing in a watery area or the manner of reproduction to insure increased survival of their young.

Plant Adaptations
Plants adapted for life in the aquatic environment can live in water-saturated soil that has low oxygen levels. While most plants absorb some oxygen from the soil through the roots, aquatic plants have developed adaptations to increase oxygen absorption. Cattails get oxygen to the roots through hollows in the stem and leaves. One way to kill cattails is to mow them very short and then flood them above the mowed stems, suffocating the plants. Bald cypress trees have developed knees to aid in oxygen absorption by the roots. Duckweeds have adapted to the aquatic environment by floating on the water's surface, with their roots dangling in the water to absorb nutrients and minerals.

Annual plants that live on mud flats have developed adaptations to allow survival in conditions where water levels fluctuate. Seed production is tied to day length, and plants rush to produce seeds before winter sets in. Some plants have delayed seed germination which allows them to build up seed banks in the soil until sufficient moisture is present.

Changing to Survive
Some species develop very specific adaptations to a habitat or feeding style. When changes occur in an organism's environment it must move or adapt, or it will die. Sudden changes (flood, earthquake, water quality change) do not allow sufficient time for organisms to adapt. Those organisms that have developed very narrow ranges of habitat requirements are extremely vulnerable to changes and probably will not survive.