The Future of Cottontails
To many Illinoisans, the cottontail (Sylvilagus floridanus) seems to be everywhere. Those who hunt cottontails, however, may wonder whether the future of this species should be taken for granted—at least in rural settings.

There has been a dramatic decrease in rabbit abundance in Illinois in recent decades. Although hunters in the late 1950s annually bagged 5-6 million rabbits, by the late 1970s fewer than 1 million were taken per year, and the number taken has risen only slightly since then. Nonetheless, the sport of rabbit hunting remains very popular and is important to local economies in the state.

A study by the Illinois Department of Conservation determined that about 163,000 rabbit hunters spent $25.4 million hunting in 1989, with each hunter logging an average of 7.7 days afield and taking an average of 10.3 rabbits during the season.

Why have cottontail numbers declined? Through the 1950s farming in Illinois was relatively compatible with the needs of rabbits. Elements of farm landscapes that traditionally contributed to an abundance of cottontails included pasture, rotations of hay and oats, fallow cropland, crop stubble left over winter, brushy field borders, and savannas. All of these components of habitat abruptly diminished during the 1960s and 1970s, when row crop production surged.

With farm landscapes continuing to change, what does the future hold for the cottontail in Illinois? Are there modern farming practices that are relatively favorable for rabbits? To address these questions, Survey biologists have initiated research studies along several fronts. For example, county-level changes in abundance are being evaluated for the mid-1950s through the 1980s. There appear to be distinct patterns in how land use and habitat conditions have changed in Illinois over the past four decades, and rabbits have responded differently to these changes across regions. Analysis of changes in the cottontail range over time may lead to predictive models of how alternative farm policies and programs might affect the cottontail in Illinois.

Another study is focusing on cottontail abundance and ecology in an area near Sibley in Ford County. Up through the mid-1970s, rabbit abundance was closely related to the amount of hay and small grains planted in this study area. More recently, however, rabbit abundance has become highly variable from year to year, with numerical trends less predictably associated with the amount of land devoted to hay and small grains.

To understand how rabbits are responding to changing habitat conditions, cottontails in the Sibley study area have been trapped (unbaited box trap), marked with ear tags, released, and then recaptured in many cases. From March 1990 through August 1992, there were 732 captures of 402 different rabbits. The mark-and-recapture study has provided information about the reproduction and survival of rabbits in the area.

Some of the trapped cottontails have also been fitted with miniature radio transmitters, which allow researchers to track the rabbits' movements. Monitoring these rabbits has provided information about their use of habitat and survival.

The intensive work in Ford County promises to further understanding of how
rabbits have responded to changing agricultural land use and how future farming practices may affect rabbit abundance. Identifying emerging farming methods that would be relatively beneficial to the cottontail would be good news for rabbit hunters as well as local economies.

This research has been funded by the Illinois Department of Conservation and U.S. Fish and Wildlife Service using Pittman-Robertson funds for wildlife restoration.

Richard E. Warner and Phil C. Mankin, Center for Wildlife Ecology

Cave Dwellers

More than 50,000 species are native to Illinois, including more than 29,000 species of insects and other invertebrates, thousands of plants, about 300 birds, more than 180 fishes, and 67 mammals. Among the native species that dwell on the surface (rather than underground), only two types of crayfish and two vascular plants are endemic (occur naturally only in Illinois). Thus, all but four of the tens of thousands of surface-dwelling species have been able to move or disperse across the Illinois border.

For species that live underground, however, moving across state lines apparently is not as easy. Of the more than 215 invertebrate species that live in caves or other groundwater habitats in Illinois, at least eight are endemic. These endemic species are special not only because they are unique to Illinois but also because they serve as natural biological indicators of groundwater contamination: the more contaminated the water, the less healthy the underground populations.

The subterranean endemics—three aquatic crustaceans (one isopod and two amphipods), three millipedes, and two beetles—are often found only in one or two caves or springs in Illinois. For example, one of the two endemic beetles (Pseudanophthalmus illinoisensis) is known only from one cave in Hardin County, and one of the amphipod species (Caecidotea leslei) has been collected only once, from a drain tile located in McDonough County.

The geographic ranges of endemic subterranean species in Illinois have been strictly controlled by a number of factors, including geology and past events of isolation (that is, ice ages). The isolation of Illinois' endemic subterranean species began perhaps 20,000 years ago with the retreat of the Wisconsinan glacier, which led to warmer and drier conditions in what is now Illinois. Subterranean species, accustomed to cool, moist environments beneath the ice, were subsequently limited to inhabiting caves and other groundwater environments, from which it became difficult to disperse to other locations.

Protecting these groundwater environments from pollution is important for conserving the endemic subterranean species; it is also important for safeguarding human health because 75% of the nation's cities and 95% of our rural areas use groundwater as a source of drinking water. Nevertheless, pollution of cave streams and other groundwater sources has become more and more evident, threatening human health and well-being. Despite legislative efforts to protect our precious natural resources, sewage, industrial wastes, agricultural fertilizers, pesticides, and other substances toxic to humans have been found in Illinois' groundwater.

Populations of endemic cave invertebrates and other subterranean aquatic life can be thought of as "biological barometers" that provide warnings about the deteriorating quality of our groundwater resources. The current condition of our groundwater is reflected in the fact that the isopod and one of the two amphipods endemic to caves and
groundwater habitats in Illinois are listed as endangered species by the Illinois Endangered Species Protection Board. Further monitoring of populations of endemic and other species of aquatic subterranean invertebrates will aid scientists in determining the extent and seriousness of groundwater pollution. Such information is vital for protecting our precious water resources as well as our own health.

Gene Gardner, Steve Taylor, and Jean Krejca, Center for Biogeographic Information

Sampling Fish in Lakes
How many fish are in a particular lake? What size are the fish? What species are they? These are questions asked by fisheries managers responsible for Illinois lakes.

To sample fish in lakes, biologists may use a wide variety of equipment, such as seines, gill nets, trap nets, and electrofishing equipment. The typical seine used in lakes is about 25 feet long and 4 feet deep. To use the seine, one person stands at each end holding poles called brails onto which the seine is attached. Usually, one person wades straight out from shore into shallow water and walks around in a quarter circle back to shore, thus trapping fish in the seine. Obviously, seines only catch fish that live in the shallow areas near shore or that happen to be there at that moment. This includes many species of minnows and the young of larger species. Because the seine can only be used in water shallow enough for wading and in areas without snags, this gear selectively captures species and sizes of fish that live in these areas. As it turns out, each of the gears used by fisheries biologists is selective in a certain way.

Survey researchers have examined the selectivity—in terms of capture efficiency—of several gears, with special emphasis on electrofishing because it can be used in a variety of habitats. Typically, boat-based electrofishing involves a flat-bottomed boat 16–20 feet long equipped with a generator for power and several electrodes mounted on long booms that extend in front of the boat (see photo). The biologist maneuvers the boat along the shoreline, and fish are temporarily stunned when overtaken by the electric field. The fish are netted, held in live wells, and then weighed, measured, and examined for other information.

Fish caught by electrofishing are rarely hurt. In fact, biologists take special care in handling these fish because any injury may bias the results of their study.
As with seining, electrofishing is selective for certain species and sizes. To examine this bias, Survey investigators conducted several experiments in ponds, reservoir coves, and small lakes that were being drained. In each of these areas, fish were sampled with electrofishing gear, marked, and then returned to the water. Next, as many fish as possible were captured by either draining the ponds or by using different sampling gears that are more efficient but also more laborious.

The proportion of captured fish that had been previously marked can be used as a gauge of the efficiency of the electrofishing gear. By examining the sizes and species of marked fish in relation to the sizes and species later captured, one can see what kind of bias results from using electrofishing.

The Survey studies found that the main factors influencing the efficiency of electrofishing sampling were water depth, the percentage of the water surface that was covered with aquatic vegetation (which affects visibility), and the length of the fish (very small and very large fish are more difficult to catch than fish of intermediate sizes).

A good example of this bias was found with largemouth bass, one of the most popular sport fish in Illinois. Under ideal conditions of shallow water (0.5 meters deep [about 1.5 feet]) and no aquatic vegetation, electrofishing captures approximately 22% of the fish that are 30 cm (12 inches) long. Under these same conditions, one catches only about 11% of the fish that are 40 cm (16 inches) long. Efficiency is even lower in deeper water with more vegetation. For example, in water 1.5 meters deep with 50% vegetation, efficiency drops to about 7% and 3% for 30-cm and 40-cm fish, respectively. In addition, capture efficiency decreases as the size of fish falls below 30 cm.

Why is this information important? First, management biologists often look at trends in populations over time to assess the sustainability of a fishery. If a lake is sampled during one year when there is little vegetation, the results will show different levels of bias, and the samples will not be comparable.

Second, managers and researchers often compare fish populations in different lakes. If one lake is deep and a second shallow, the sampling efficiency will differ greatly, and the results of these studies will not be comparable. When we know the capture efficiency of electrofishing, we can estimate the actual populations from our samples, thus accounting for changes in conditions that affect sampling efficiency. This more accurate information gives managers and researchers a more meaningful tool for managing and investigating the aquatic resources of Illinois.

Douglas J. Austen and Peter B. Bayley, 
Center for Aquatic Ecology

Searching for Rare Plants

Of the approximately 3,200 types of plants that grow wild in Illinois, roughly 2,200 are native to the state. About one in six of these native species is rare—that is, considered endangered or threatened. Endangered plants are those in danger of extinction in Illinois, and threatened plants are those likely to become endangered within the foreseeable future. Presently, 22 plant species historically known to have been in Illinois are thought to no longer occur in the state, and an additional 40 plants have not been seen in Illinois for more than 20 years.

It is important to know the location of rare plants to prevent their loss through continued destruction of natural habitats.

Several factors have contributed to the rarity of some of these native plant species. One is the destruction of natural habitats by urbanization, expansion of agricultural lands, and other types of land development. Illinois, in fact, ranks second in the nation in the percentage of natural habitats lost. Other factors include competition with nonnative plants, commercial exploitation, and the fact that some of the species are at the edge of their natural distribution in Illinois (and are thus perhaps only marginally well-suited for living in Illinois).

It is important to know the location of these rare plants to prevent their loss through continued destruction of natural habitats. These rare plants are a part of Illinois’ heritage and provide information about the state’s natural environment. They provide this information through their specific environmental growing requirements, such as wet-mesic prairies, fens, sand prairies, sand savannas, limestone ledges, sandstone cliffs, hill prairies, acid lakes, calcareous lakes, cold-water lakes, rich mesic forest, and many others.

Searching for rare plants requires a knowledge of the state’s plants, access to historical dried plant collections in herbaria, botanical literature, maps, and most of all the patience to make a thorough search of potential sites. The most vital tool in locating a certain plant is experience. Once you see a particular plant growing in its natural habitat, you gain insight into its growth habit, what plants it generally grows in association with, and its natural community requirements; this insight enables you to predict additional areas where it may be found. If firsthand experience is lacking, you can talk with someone who has seen the plant growing in its natural habitat, or perhaps the individual will even take you to the site so you can develop your own ideas about its habitat requirements.

Herbarium collections are a valuable source of information on plants. More than 500,000 plant specimens have been collected in Illinois and are deposited in various herbaria throughout the state. The earliest recorded plant collection in Illinois dates back to 1795 and was by André Michaux, a French botanist. Such
records provide a historical account of plants collected in Illinois. The label on a herbarium specimen will provide information on where the plant might again be found and the time of year when the search should be made.

Botanical literature provides additional valuable information, such as height of the plant, habitat preference, distinguishing characteristics, flower color, flowering and fruiting times, and known geographic distribution. Because rare plants are sometimes difficult to distinguish, one must often consult several books to gain a greater insight on the plant to be located. Occasionally, some references provide incorrect information about a plant’s growth and habitat requirements; this is especially true of the little-known rare plants.

Other sources of information, such as state maps, soil maps, topographic maps, gazetteers, and aerial photographs provide greater detail and extremely valuable information for plant searches. As maps continue to improve in detail, so does the information found on plant specimen labels. As a result, more recently collected specimens generally provide the best information about where to look for a particular plant. Soil maps also provide excellent clues about where to search. Plants have specific growth requirements, and many can be located by searching for specific soil types. In some states, rare plants are listed according to soil type and habitat.

It is necessary to visit more than one site when looking for a specific plant because the site may not appear as expected or the habitat may have been destroyed. When the plant’s preferred habitat is located, you may need to spend several hours or even all day looking for the plant, and you should look for as many of the habitats in the surrounding area as possible. For example, rare plants on hill prairies most likely have not been found on all hill prairies; they may be located only in specific places such as on west-facing slopes. Although slight habitat differences may seem insignificant, they are often very important for rare plants. Because plants vary considerably in their requirements for growth, reproduction, and means of dispersal, some plants may be found in only 10% or fewer of the habitats where they might be expected to be found.

It should be noted that taking a rare plant from its location is prohibited without written consent of the landowner. The sale of endangered or threatened plant species is also prohibited.

Loy R. Philippe, Center for Biodiversity

New Educational Publication

Wetlands are the subject of a new educational publication from the Survey. Intended primarily for use in middle school classrooms, *Wetland Wonders* provides teachers with necessary background information relating to wetlands and includes detailed descriptions of 12 educational activities for students. Some activities rely on student handouts, and copies suitable for reproduction are included.

The publication comes with a set of 20 high-quality color slides, as well as a sample copy of a poster depicting 31 wetland plants and animals. Suggestions for how to use the slides and poster in conjunction with the text are included in the publication; an appendix provides commentary on each slide.

Issued as Special Publication 14, *Wetland Wonders* is available for $7. This price covers the cost of the supplementary materials, including the slide set. To obtain a copy, write to Distribution Center, Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820, or call 217-333-6880.

Illinois Beach State Park, the natural habitat of a threatened plant called the sea rocket.

The sea rocket.
Gray Fox
On a warm spring day the trees are beginning to bud, and the migrating warblers have returned. While scanning the trees to identify each colorful warbler, you notice something large and grayish—too big for a bird or a squirrel and too gray for a bobcat. Closer inspection with the binoculars reveals a doglike mammal.

After consulting a little-used field guide that happens to be in your day pack, you determine that the “dog-in-the-tree” is, in fact, a gray fox—the only fox with climbing ability. Using the sharp, curved claws on their forepaws, gray foxes grab hold of bark and boost themselves up with their hind paws. They use this climbing ability to ambush prey, obtain food such as bird’s eggs or nestlings, escape enemies, take refuge during the night, stand look-out, or merely laze away the day.

Related to the coyote and wolf as well as the red fox, the gray fox, *Urocyon cinereoargenteus*, has a pepper-and-salt coat and a long, bushy, black-tipped tail with a median black stripe. An animal of forests, bluffs, and river bottoms, the gray fox can be found throughout Illinois but is more abundant in the southern third of the state and near the Mississippi and Illinois rivers. Although gray foxes usually remain in wooded areas, they sometimes stray into brushy or wooded pastures. Because of their lower population numbers, nocturnal habits, and propensity to stay closer to hiding places and under cover, gray foxes are seen much less often than red foxes.

Although gray foxes prefer to eat rabbits, mice, or voles, they are omnivorous and will eat berries, fruits, acorns, and seeds as well as birds and insects. When food is abundant, they will stuff themselves and become very fat.
**Characteristics of Seven Main Orders, or Categories, of Mammals in Illinois**

Cut out the drawings from below and glue each in the correct box. You may color the drawings if you wish.

<table>
<thead>
<tr>
<th>Order Marsupialia</th>
<th>Order Insectivora</th>
<th>Order Chiroptera</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 toes/foot; scaly tail; opposable thumb on back foot</td>
<td>small with pointed nose; tiny, beadlike eyes; 5 toes/foot</td>
<td>hand formed into a wing; thumb is free and has a claw</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Order Lagomorpha</th>
<th>Order Artiodactyla</th>
<th>Order Carnivora</th>
</tr>
</thead>
<tbody>
<tr>
<td>short, furred tail; large upper teeth for cutting; large hind feet</td>
<td>foot is hoofed; antlers may be present</td>
<td>large canine teeth; clawed toes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Order Rodentia</th>
</tr>
</thead>
<tbody>
<tr>
<td>large upper and lower gnawing teeth; relatively small</td>
</tr>
</tbody>
</table>

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"The Naturalist’s Apprentice" presents educational activities for middle school students. Teachers are invited to photocopy this feature for classroom use.
Slime Molds

Slime molds are an interesting group of organisms with both plant and animal characteristics. One of the plant characteristics is the growth of spore-bearing fruiting bodies, which often have interesting forms. One species, for example, made Ripley's "Believe It or Not!" for being described as hair growing on wood.

The animal characteristics of slime molds are apparent when their spores germinate into amoeboid bodies that develop flagella, move, feed, and divide as do protozoa. These amoeboid bodies, called myxamoebae, fuse and form a plasmodium, a mass of protoplasm with many nuclei. Plasmodia vary in color and size, depending on the species. Lycogala, a common genus, is named for its coral-red to cream-colored plasmodium, which the ancients thought was wolf's milk and thus named with the Greek words Lyco (= wolf) and gala (= milk).

Plasmodia may be confined to their substrate (wood or ground, for example) or cover many substrates, and they can attain a size of several feet or more and function as a giant amoeba. Just before the fruiting or spore-forming stage, the amoeba emerges from its substrate to appear on the surface. The "Texas Space Monster" that made headlines in 1972 was a large plasmodium bubbling up on lawns in Texas. Plasmodia feed by engulfing bacteria and other microorganisms found in or on the substrate and are regarded by many scientists as animals.

At maturity the plasmodia assume the shape of stalked or sessile sporocarps, structures in which spores are produced. The spores, which may be pallid or a variety of colors, are generally globular, with a rather thick wall. They are exceptionally resistant to unfavorable conditions, including prolonged periods of desiccation. Sporangia (the cases in which the spores are carried) may have sterile threads called capillitia, which aid in spore dispersal.

Slime molds have been widely used in research. They can be grown on moist filter paper with oatmeal as a food source. The large plasmodia are used in cell physiology experiments, especially those on calcium and phosphorus metabolism and cell movement. The myxamoebae are often used as bioassay organisms. They can be used, for example, to evaluate the vitamin content of instant oatmeal, which may lose its B vitamins during processing. The myxamoebae (as well as the plasmodia) die quickly on a diet of vitamin B-deficient oatmeal.

J.L. Crane and J.D. Schoknecht (affiliate), Center for Biodiversity

Ornamented spore of the slime mold Fuligo megaspora.